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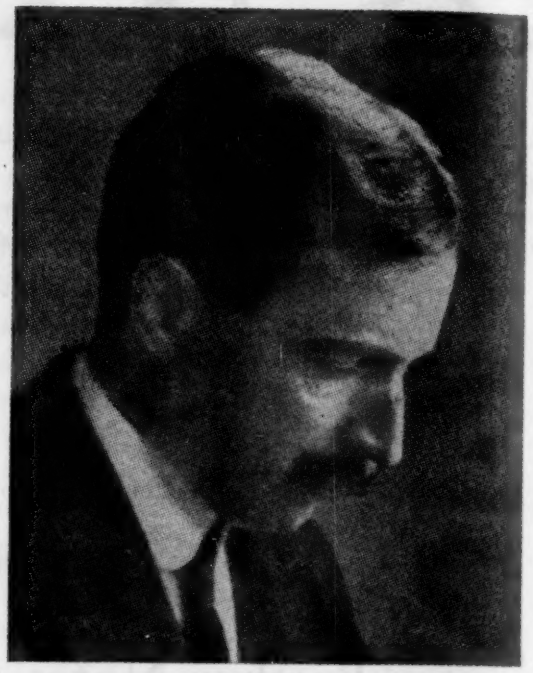

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SCIENCE

Vol. 103, No. 2667 Friday, February 8, 1946

Uniform Luminescent Materials[1]

C. G. A. Hill, A.R.C., B.Sc.

Material Research Laboratory, Philips Lamps, Ltd., London, England

THE PHENOMENAL INCREASE in the production of luminescent materials in Britain since the advent of fluorescent lighting has raised manufacturing problems of a type not usually associated with inorganic preparations. These problems are due to the difficulties which arise when attempts are made to produce large quantities of material having uniform luminescent characteristics.

There are several properties of luminescent material, or phosphore, which may be considered its luminescent characteristics. The physical properties of all crystalline solids can be divided into two classes: those which are the same for any two specimens of the same material, and those which are influenced by the past history of the particular sample. The "structure sensitive" properties which form the second class are often very sensitive to the presence of small amounts of impurity. Luminescent characteristics of inorganic solids which fall into this class are as follows:

(1) *Excitation spectrum.* Most materials are excited by a broad band of wave lengths in the ultraviolet, having one main, and possibly subsidiary maxima. The position of the band usually coincides with the long-wave length edge of the fundamental crystal absorption, but the details will depend on the method of preparation (Fig. 1).

(2) *Emission spectrum.* The energy distribution of the emitted light is often the most important characteristic of the material, because it determines the color. In certain cases this is very difficult to control. In commercial phosphores it consists of one or more bands from 500 to 3,000 angstroms wide, and it may extend considerably into the ultraviolet.

(3) *Efficiency.* No absolute value can be given to the efficiency of any luminescent material which will be significant in all its applications, because of the complexity of the phenomena involved. For practical purposes, therefore, it is customary to compare the relative efficiencies of different materials under conditions of excitation similar to those met with in use. In excitation by ultraviolet light the quantum efficiency is a significant figure; but this must be coupled with the wave lengths of excitation, and emission of the energy conversion is required (since the energy of one quantum E, of wave length λ, is hc/λ), and finally, the sensitivity of the eye to light of different wave lengths must be considered if the light output is to be estimated from any absolute physical measurements.

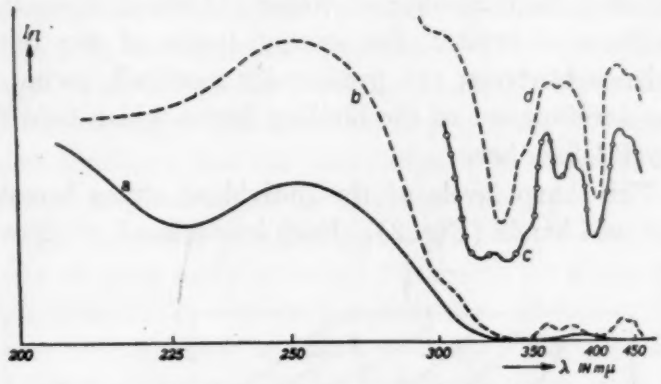

FIG. 1. Excitation spectra of zinc silicate phosphores at room temperature: *a*. Zn_2SiO_4—Mn 1‰; *b*. Zn_2SiO_4—Mn 5%; *c*. Zn_2SiO_4—Mn 2% (band system enlarged); *d*. Zn_2SiO_4—Mn 5% (band system enlarged).
(*After* Kroger, *F. A. Physica,* 1939, **6**, 764.)

In cathode-ray tubes the efficiency of the luminescent material is often a function of the electrical characteristics of the tube, the thickness of the layer of material and the nature of its support, while in the case of X-ray screens the efficiency is largely determined by the absorptive power of the material and so will vary with the wave length of the radiation used.

(4) *Phosphorescence.* Of the total energy which is absorbed during the excitation of a phosphore, a part is emitted immediately (fluorescence), a part is degraded into heat, and a third part may be stored for a period within the crystal, to be liberated later by either of the above processes. The phosphorescent characteristics of the material are determined by the total amount of energy which is stored within it and the rate at which part of this energy is re-emitted as light. It is difficult to specify these characteristics absolutely, and for practical purposes relative measurements are used. The requirements of various applications differ widely. Some may require

[1] Acknowledgments are due to Mr. J. A. M. vanMoll and the Directors of Philips Lamps, Ltd., for permission to publish this paper.

complete extinction within a few milliseconds, while others may need a continuous glow lasting several hours.

In addition to these specifically luminescent characteristics there are all the usual physical and chemical properties of any pigment, such as particle size and stability. The control of each brings its own problems.

Theoretical Framework

Only a very brief outline can be given here of the theoretical framework by which these properties are related to each other and to the composition and method of preparation of the phosphores. Several reviews have been published in recent years which deal with the matter in greater detail (*1*).

The electrons of an atom in a gas, as is well known, occupy certain discrete energy states and can be excited, by various means, into other states of higher energy provided that these are not already occupied. Such transitions are accompanied by the absorption or emission of practically monochromatic radiation. When a large number of atoms are brought together to form a crystal, the energy levels of the outer valence electrons are profoundly modified, owing to the development of the binding forces which hold the crystal together.

The sharp levels of the individual atoms broaden out into bands (Fig. 2). Each broad band of allowed

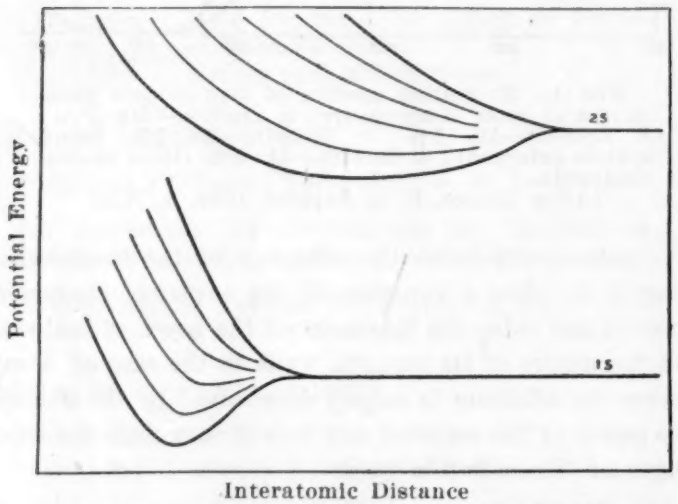

FIG. 2. (*After* Shockley, *West. Bell System Tech. J.*, 1939, **18**, 645.)

energies is made up of discrete states, but these are so dense, being equal to the number of ions in the crystal, that they can be considered as continual. It is no longer possible to say that any particular electron is associated with any one particular ion; they are all shared by the whole lattice. The electron population of any band is limited by the fact that each of its component levels can be occupied by only two electrons having opposite spins. In all ionic crystals there is a filled band in which every allowed level is fully occupied, separated by a gap of several electron volts from the next band above it, which is normally empty.

Electrons may be excited into this upper band by the absorption of a quantum of radiation of sufficiently short wave length, and once there, in a perfect crystal, they would be free to move under the lattice under the influence of an applied electric field. An excited electron will eventually return to the lower band, either by a direct transition with the emission of a quantum of radiation, or by a more complex mechanism, connected with the thermal vibrations of the lattice by which the energy is lost as heat. For most pure substances, at ordinary temperatures, the latter is the case.

If, however, the energy gap between the two bands is bridged here and there by other allowed energies, light emission is more likely to take place. This is just what may happen when a small amount of an impurity ion is introduced into the crystal lattice. The discrete levels of the impurity ion, which remain localized in its neighborhood, may fall within the forbidden energy gap. The excited electrons may then fall from the upper band to one of these levels, emitting a band of wave lengths, the position of which will depend on the size of the energy gap between the bottom of the band and the impurity level.

When the impurity ion possesses a large number of closely spaced levels in this region, there is even less chance of a visible emission than for the pure substance, as transitions between these levels will result only in the emission of very small quanta in the infrared. These two possibilities correspond to the action of "activators," without which many materials will not luminesce strongly at room temperatures, and "poisons," the presence of which kills luminescence which would otherwise be evident.

Theory at present gives little indication of the concentrations at which activators should be used, but empirical data show that optimum concentrations vary for different methods of excitation of the same material, apart from wide variations between different materials (Fig. 3).

The introduction of the activator produces strains in the lattice, and these result in local disturbances of the energy bands. Similar effects are also produced by a number of other types of lattice defect which are present in all normal crystals. They are usually due to the displacement of lattice ions from their normal positions. Electrons excited into the empty band may become trapped in the neighborhood of these defects, to be liberated later by thermal

vibrations. These electrons account for the very long phosphorescence of certain materials. The number and type of defect can be controlled to some extent by the heat treatment given to the material.

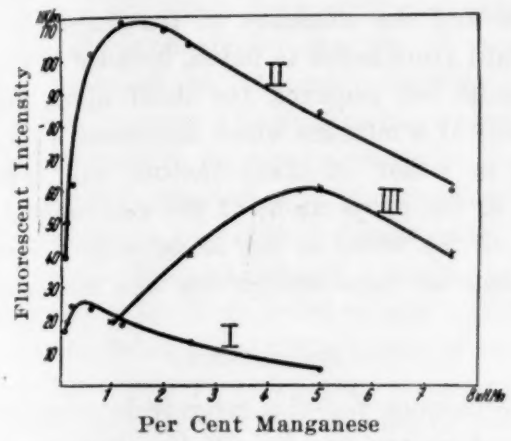

FIG. 3. Effect of manganese concentration on the fluorescent intensity of zinc silicate excited by (I) 740 A.U., (II) 2,537 A.U., and (III) 3,650 A.U.
(*After* Ruttenauer, *A.Z. Tech. Phys.*, 1938, **19**, 148.)

PRACTICAL ASPECTS

The mechanism of luminescence gives some explanation of the necessity for extremely careful control of every stage in the manufacture of a phosphore. There is, however, a considerable variation in the tolerances which can be allowed as between one phosphore and another. In one case the emission spectrum may be invariable and the efficiency sensitive only to the heat treatment and the purity, while in another case the emission spectrum may be sensitive to very slight changes in the composition and the firing schedule.

For certain purposes the particle size must be controlled within narrow limits at about a two-inch diameter. Normal methods of comminution can seldom be used freely, because of the destructive effect of grinding on the luminescence, so that efforts have been made to produce the material with the correct particle size in the first place.

Below are details of the preparation of three luminescent materials which are suitable examples of the three most important chemical classes: the silicates, the tungstates, and the sulphides. For this purpose it is assumed that the two first are to be used in a normal fluorescent lamp and that the sulphide is to be a component of a white television screen.

Zinc beryllium silicate. This material, which is activated by manganese, can be prepared so as to fluoresce with any color between a very greenish yellow and a deep orange. The first step in its preparation is the purification of its constituent oxides. Various methods can be used to purify the zinc, beryllium, and manganese, most of which rely on well-known reactions of analytical chemistry. The purification is sufficient in this case when the copper, iron, and nickel content are all below 0.001 per cent and that of all other heavy metals is less than 0.01 per cent (*2*). The silica can be purified by distillation of an organic compound, such as ethyl silicate, which is hydrolized to give a silica gel (Brit. Pat. 498,556). Suitable proportions of the oxides (depending on the required color) are mixed with the silicon compound, which is then hydrolized and the mixture dried and pulverized. Useful luminescent materials can be prepared in which the ratio of SiO_2 to metal oxides differs widely from that indicated by the orthosilicate formulas, Zn_2SiO_4 and Be_2SiO_4. Materials in which the proportions vary as follows have been patented (Brit. Pat. 5131584):

ZnO	10—60%	SiO_2	11—88%
BeO	1—40%	Mn	1—15%

The dry powder is then fired in a silica vessel to a temperature between 1,000° and 1,250° C., held there for up to two hours, and finally cooled, either in air or by immediate quenching in cold water. The precise details of this heat treatment have a considerable effect on the emission spectrum and the phosphorescent behavior of the resulting material. It is therefore necessary to control them as closely as possible, and to ensure that the whole of each batch reaches the same temperature in the furnace.

The material is then ground to the desired size, and in some cases a second firing may be given after the grinding to restore the efficiency. If this is done, special care must be taken to avoid sintering of the powder. Various special techniques have been suggested for avoiding this, such as blowing the powder through the furnace as a cloud of dust (U. S. Pat. 2,196,082).

Magnesium tungstate. No activator is required for this material, which invariably fluoresces with a blue-white color. Its efficiency and stability, however, are very dependent on the purity of the materials used. The magnesium oxide may be purified by standard chemical methods. The tungstic oxide is passed through a cycle, familiar in the preparation of pure tungsten for lamp filaments, in which ammonium tungstate is recrystallized and converted into tungstic acid and the acid dissolved in ammonium hydroxide and recrystallized as ammonium tungstate. The cycle is repeated until the material is sufficiently pure, the limits in this case being of the order of 0.005 per cent for iron and copper (Brit. Pat. 5131584).

The oxide for carbonate of magnesium is mixed as a wet paste with the tungstic acid, dried, ground, and fired at 1,000° C. for one hour (Brit. Pat. 469,732). As in the case of the silicate, a second firing may be necessary after the material has been ground to size.

Zinc sulphide: copper. Pure amorphous zinc sulphide is first obtained by precipitation with hydrogen sulphide from a purified zinc solution. The tolerated amounts of heavy metal impurity are very much smaller than for the silicates, quantities of 0.0001 per cent of iron or nickel having a marked effect on the luminescent characteristics. The dried precipitate is then mixed with about 2 per cent of sodium chloride and 0.1 per cent of copper chloride (Brit. Pat. 550,800). The mixture is fired in an atmosphere of nitrogen for two or three hours at 1,100° C., after which any sodium chloride remaining is washed out with water. The resulting material has a strong green emission, while its phosphorescent properties will depend on the details of the heat treatment. The role of the sodium chloride in this preparation is to increase the rate of crystallization and to lower the temperature necessary for rapid diffusion of the activator into the lattice. Fluxes of this sort are also used to control the particle size of the product.

Sulphides differ from the other types of phosphore, in frequently exhibiting the emission spectrum of more than one activator at the same time. All zinc sulphides emit a blue band, which can be attributed to interstitial zinc atoms. The distribution of the emitted energy between this and the added activator band is influenced by the concentration of the activator and also by the intensity of the excitation. This causes slight changes in the fluorescent color as the intensity is altered, and similar changes may occur during the phosphorescence, as each band decays independently of the other.

In each of these examples it is essential that both the color and the efficiency of the materials should be constant from batch to batch, because in each case the color is not required for itself alone but as a component of a mixture which fluoresces white. Any changes in either of these factors will necessitate changes in the proportions of the components of the mixture if the white is not to be altered, and such adjustments are most undesirable in a manufacturing process.

Conclusion

The techniques for the large-scale production of luminescent materials are still largely experimental, but there can be little doubt that when their development has been completed, they will influence a wide field of chemical manufacturing processes outside their own immediate sphere.

References

1. Review articles: Hill, C. G. A. *Chem. Prod.*, 1944, 7, 43; Leverenz, H. W., and Seitz, F. *J. appl. Phys.*, 1939, **10**, 479; Randall, J. T., and Wilkins, M. F. H. *Rep. Progr. Phys.*, 1939, **6**, 174; Rees, A. L. G. *Ann. Rep. chem. Soc. Lond.*, 1943, **39**, 73; Seitz, F., and Johnson, R. P. *J. appl. Phys.*, 1937, **8**, 84, 186, 246.
2. Marden, W. J., and Meister, G. *Illum. Eng.*, 1939, 34, 563.

Another Chain Reaction

Katherine Chamberlain
Professor of Physics, Wayne University, Detroit

TWICE IN THE PAST THIRTY YEARS the nations of the world have been placed in situations from which there has been no escape except by war. Now, with the advent of the atomic bomb, the problem of what to do to prevent the recurrence of this takes on an urgency that has never existed before. Time after time we have seen aggressive, organized minorities force large numbers of people to conform to their wishes with disastrous consequences. What the world has never yet seen is an equally well-organized effort on the part of people of good will for constructive purposes.

Professor Smyth's report, *Atomic energy for military purposes,* makes it clear that protection against the destructiveness of the atomic bomb is futile. No countermeasures offer any hope except international agreement by all nations that this instrument shall not be used again for war. The difficulty will be to get the agreement. Moreover, it will take time and meanwhile an international race for atomic bomb supremacy may get started that will leave each country no alternative except to inflict upon its citizens the waste of human and material resources required to meet this threat. In addition to agreement by the governments of the world, a very extensive program of education will be necessary to insure the support of the governed if enforcement is to be practical.

It is clear that the leaders in the development of the atomic bomb are fully aware of the potentialities of what they have brought into being and are doing everything possible to keep the race for supremacy from starting. On the part of the rest of us scientists, however, two attitudes of mind are quite common, both of which seem to me equally to be regretted. The first of these is represented by deep dismay, coupled with a generally hopeless feeling that there is nothing that we can do about it. The second expresses the conviction that scientists must pursue their unfettered way in quest of truth regardless of consequences and that responsibility rests elsewhere to pre-

vent dire results. Moreover, the vastness of great research teams may confer on many of the individuals who participate an anonymity that robs them of their sense of personal responsibility.

The successful outcome of the recent effort to release atomic energy for destructive purposes represents the most extraordinary example of cooperation under the guidance of talented leadership that the world has ever known. The outstanding success of the enterprise appears to be due primarily to the ability of the leadership coupled with the urgency of war and the possession of unlimited resources. By all odds the most important element was the leadership.

It has been my privilege to see several of the people who have contributed to the development of our knowledge of radioactivity at sufficiently close range to be quite certain that a group less inclined to present the world with this means of destruction would be difficult to imagine. To the very great, physics is still natural philosophy, and the search for truth for its own sake is very common. Heretofore, it has always been the highest compliment that could be paid a scientist that he sought the truth without fear or favor. But, now, a moral dilemma of appalling proportions has been injected into the search. Is love of truth to be paramount, or love of mankind? Is the immediate advantage of one's own country to be the primary consideration or the welfare of the world? Will man be equal to this great responsibility that he must now assume? The idea is not new that he sows the seeds of his own destruction when he seeks to usurp power that transcends his wisdom.

If something analogous to a chain reaction could be set off by the scientists of the world to arouse people generally to an understanding of the necessity for an international agreement, world-wide and implemented with power to enforce its dictates, we might see an aroused and determined public demand the laws that are needed. This is in no sense a proposal that we scientists should become the self-appointed guardians of civilization. But, as the group that is in the best position to appreciate the disastrous potentialities of atomic energy without adequate control and as one not likely to be carried away by hysteria or panic, we should be able to arouse other people to the realization that nothing else greatly matters if this problem is not solved.

As a first step, it seems appropriate to inquire whether the great laboratories that are likely to be the fountain heads of continued nuclear research cannot make public a statement of policy to reassure people generally that the millions they contemplate spending do not mean more bombs or a blind lack of sense of social responsibility. Anyone who is acquainted with them knows all this perfectly well, but the great majority of people do not know them and will certainly be much more inclined to cooperate if convinced that they are not rather sinister places that should be feared.

The directors and senior research staffs of these laboratories probably do not include more than one hundred persons in the entire world. Moreover, the lines of international communication are at their best in science. Most of these people are personally acquainted with one another, which is an enormous aid to understanding. If they were to publish an agreement that no further investigations involving release of atomic energy for military purposes would be carried on in the laboratories under their jurisdiction, the case against the atomic bomb would have the direct sanction of very exalted authority.

Granting that such an agreement by existing laboratories might result in the attempt to establish others with large government subsidies, these will be nothing but warehouses for apparatus unless they can be staffed by very able scientists. Such scientists are not likely to be attracted by offers, however attractive, that exist only because the established laboratories have decided that certain types of research are not in the public interest. Moreover, without very able scientists to coordinate the work, interpret the results, and keep up morale in these dangerous pursuits, it is very doubtful whether they could function effectively. Actually, it is a fair inference that such control is already under way, but the publication of it might be an enormous aid in achieving understanding.

The objection may be made that it is impossible to separate the constructive and destructive aspects of atomic research. And, yet, this has been done very effectively in the case of electricity. While we rarely want to release its more titanic aspects in our laboratories, control of its tremendous forces is so well understood that the General Electric Company did not hesitate to produce the beautiful spectacle of man-made lightning at the Century of Progress before large crowds.

Neither does the argument seem quite sound that war can now be made so terrible that no country would dare to embark on it with atomic bombs. Fear of consequences has never permanently deterred man from anything, and panic does strange and dreadful things to the character and judgment even of the best of us. If the atomic bombs are ready and war seems imminent, might not a country that is fundamentally peace loving succumb to the temptation of using them first?

It will mean a lot if society can so order things

that it will not need to call upon large numbers of its young men in the atomic age to stand guard over the stratosphere. It will mean even more if it will be possible to stop the spread of fear, suspicion, and hate in the world that a race for atomic bomb supremacy will precipitate.

When scientists confined their attention to things like falling bodies, the origin of species, or the motions of the planets, we could afford to smile over the belief of some of their contemporaries that they were a menace to society. But when we seek to recreate elements that possibly had to disappear by radioactive disintegration before the earth originally could become habitable and to release energy at rates never before experienced by man at distances less than that to the sun, we know that we are setting loose forces that are fearful to contemplate. Freedom to carry on such investigations is accompanied by a very terrible responsibility. Very clearly it must rest on all who contribute in the slightest particular, directly or indirectly, to atomic research. This is a plea that those of us who had no direct part in the development of the bomb help those who had to carry this responsibility.

Scientists have always lost control over their inventions and discoveries as soon as the creative phase was completed.

Can't we act while there is still time?

Can't the leaders in these great laboratories in which nuclear research will be carried on state publicly their opposition to further work on those aspects that need to remain military secrets?

Can't all of us in science enter the atomic age with full realization that scientific freedom must be redefined?

Can't we all make a concerted effort to help to educate people generally regarding atomic energy until the thousands of ourselves become the millions who must be convinced if international agreements are to be permanently enforced?

As evidence of our good faith, can't we get Congress to close those plants at Oak Ridge and at Hanford and keep them closed until plans for the control of their products can be worked out?

Then, can't we go to the rest of the world in the same spirit that has made collaboration in the physical sciences so effective in the past and offer all nations complete cooperation while we work to develop the constructive uses of atomic energy and the federation for world security—together?

Science Legislation

Further Notes on Science Legislation

Robert Chambers
New York University

A welcome feature in *Science* is the periodic publication of items of interest concerning the pending science legislation in Congress. The fact that such legislation was being contemplated was brought last September to the attention of workers at the Marine Biological Laboratory at Woods Hole when questionnaires were distributed by Dr. Howard Meyerhoff of the AAAS for the purpose of securing information as to the desires of scientists regarding the organization of a National Science Foundation. A widespread response in favor of the establishment of such a foundation was expressed, together with the conviction that the control of the Foundation should be primarily by the scientists themselves. Such a form of organization appeared to be best expressed in the original Magnuson Bill and not in the original Kilgore Bill, which placed the control in the hands of a single administrator appointed by the President.

During October, hearings on Science Legislation were instituted by Senator Kilgore, who invited the participation of Senators Magnuson and Pepper and their subcommittees and also Senator Fulbright. Approximately one hundred witnesses, including scientists and other experts, appeared at the hearings, and over one thousand printed pages of testimony were taken. The Union of the American Biological Societies and the American Biological Society took active part in inviting biologists and in urging that the biological sciences be considered separately from the medical sciences. One full day was reserved for testimony on the biological sciences, and we now have assurances from both Senator Magnuson and Senator

Kilgore that in their revisions biology as distinct from the medical sciences will be considered on a par with the physical, chemical, and mathematical sciences.

Concerning the top administration of the proposed foundation, the opinion of scientists in general has been one of favoring a board of scientists. This has persisted, in spite of the fact that some of the testimony at the hearings presented cogent reasons in favor of a single Administrator responsible to the President and the Congress.

Subsequently, the Letter to the President, drafted by the Bowman Committee and endorsing the principles presented in Senator Magnuson's Bill, was drafted and widely published (*Science*, 1945, **102**, 45). Some regarded the stand taken in the letter as uncompromising. This would be most unfortunate, since both the Magnuson and Kilgore Bills are still in committee and open to revision for the cooperative formulation of a bill which will be acceptable to governmental procedure without loss of the prerogative of free initiative in scientific research. An uncompromising attitude, fancied or real, at this stage, may jeopardize the enactment of a measure so overwhelmingly approved of in the October hearings in Washington. More recently a Committee for a National Science Foundation has been formed (see *Science*, 1946, **103**, 11, 45) claiming to sponsor no one bill but to stand for a general cooperative effort toward the realization of a Federal organization for the advancement of science in this country. The original Kilgore Bill contained several provisions unacceptable to scientists at large. The recent draft, S. 1720 (printed in *Science*, 1946, **103**, 39) is a complete revision in which most of those provisions have been eliminated. This draft is presented by the Subcommittee as a preliminary report for further comment before it is reported out of committee.

It is suggested that this draft serve as a basis for further discussion toward the enactment of a bill acceptable to scientists and Congressmen alike.

The publication of the Letter to the President by the Bowman Committee has been most valuable in awakening scientists to the implications involved in setting up a National Science Foundation. Its endorsement by so many prominent scientists has presented to the Congress and to the country how jealously the scientist maintains his conviction that scientific endeavor shall, under no circumstances, be trammeled or regimented by government or by any individual.

At the same time it behooves us to assist in the formulation of a bill which comes within the framework of accepted constitutional procedure. There should be no need for dividing into two camps. We have every right to differ on details, but the proposition is so big that we surely can agree on the big principles for the embodiment of a federally sponsored foundation in which adequate freedom of scientific enterprise will be maintained.

Several suggestions come to mind for the appointment of the top administration of the proposed Foundation. One is that two panels of names be prepared by the National Academy of Sciences, which should set up a mechanism for receiving nominations from accredited scientific societies. The President might then appoint the Administrator and the Advisory Board from the two panels. It is hoped that amendments now under consideration will achieve the desired result, namely, a National Science or Research Foundation the operations of which will be guided by the experience and wisdom of scientists, and in which scientists themselves will be induced to take responsibility commensurate with their experience and wisdom.

S. 1720 *vs.* S. 1777

Howard A. Meyerhoff
Executive Secretary, AAAS, Washington, D. C.

S. 1720 IS UNDERGOING FINAL REVISION and redrafting, and there is every reason to believe that the bill which reaches the floor of the Senate will be acceptable to the vast majority of scientists. The bill was distributed widely in Subcommittee Report No. 7, with an invitation to submit constructive suggestions. It was evident that S. 1720 had effectively met the more serious criticisms that had been directed at S. 1285 and S. 1297, and that opposition to S. 1720 as a whole on the part of any group would merely be regarded as obstructionism. At the same time, despite the marked improvement in the new draft, several minor provisions and at least two major ones called for further discussion.

For this purpose Senator Elbert D. Thomas, of Utah, arranged a preliminary meeting at which Messrs. Bush and Bowman discussed differences with Senators Kilgore, Magnuson, and Thomas. A more formal meeting was held on 23 January with Senator Saltonstall presiding. Although some question has

arisen regarding the propriety of giving representatives of the Committee Supporting the Bush Report a hearing practically to the exclusion of other interested groups, the procedure was expedient and practical. The Committee for a National Science Foundation, which draws more widely among scientific fields for its support, had indicated its acceptance of the major provisions of S. 1720; hence, it was important to get the viewpoint of the Committee Supporting the Bush Report, which had at one time entertained the idea of opposing any bill except S. 1285.

Although it is unsafe to predict the changes which will be made in the provisions of S. 1720 by the time it is reported out of committee, there is now unanimity among scientists regarding the need for a National Science Foundation. The Committee Supporting the Bush Report recognized that the President cannot be restricted in his appointive powers and is satisfied that a strong board which may submit nominations for the post of Administrator, and which can check or balance the Administrator at crucial times, will adequately protect scientists from possible political control or domination.

Social Science

This Committee is still convinced that the Social Sciences should not be included in the Foundation, but chiefly because of the fear that lack of definition and vagueness in stated aims and functions in the field may militate against the passage of the bill. The fact is that the social scientists, through the Social Science Research Council, are ready and willing to define their field, their aims, and their functions and will welcome the opportunity to accept the same rigorous standards as apply in the physical, biological, and medical fields.

Patents

Even on the issue of patents it is unanimously agreed that the patent provisions of S. 1720 are basically sound; that they do not involve patent reform or new legislation; and that the purpose of the bill to standardize patent policy within the government agencies is worthy of support. Here again the fear is expressed that such provisions will arouse opposition which will jeopardize the entire bill.

Remaining Question

Whether or not these fears are well founded, the question still remains: Should desirable elements be excluded in committee on the chance that they may generate some opposition on the floor? Any answer to this question must be qualified. If such provisions are irrelevant, it is foolhardy to load the bill with them. If they expose the bill to a serious risk of defeat, they may wisely be sacrificed. But if the are desirable provisions, the political expediency scrapping them before the existence of opposition known or its strength ascertained is doubtful.

At this moment other hazards appear more serio than these. The Senate is becoming increasingly pr occupied with other matters, and the interest whi was evident last fall has waned. The House is scarce aware of the proposed legislation; and with sentime for economy rising, it can easily consign the bill painless death in committee. There is comparativel little public pressure upon Senate or House to pa such legislation, and even though many scientists ha written interested Senators, the impression given h been one of internal dissension, which provides dubious background for Congressional action.

A New Hazard

Without question the most serious hazard whi must be faced comes unexpectedly from a new quarte On 30 January Senator Willis (Ind.), with Senato Hart (Conn.), Hawkes (N. J.), Hickenlooper (Ia. Smith (N. J.), Stanfill (Ky.), Wiley (Wis.), an Young (N. D.), introduced S. 1777 into the Senat The Bill proposes that the President appoint a sel perpetuating committee of 50 from a list of nomine submitted by the National Academy of Science for th purpose of administering a limited program of scien tific activity. This solemn proposal ignores the wor performed by Vannevar Bush and his committees; b Senators Kilgore and Magnuson and their respecti subcommittees and staffs; by more than 100 scientis who prepared and presented testimony at the Octob hearings; by more than 100 scientific organizatio which have painstakingly studied the bills already be fore us; by the Committee Supporting the Bush Re port, which has ardently worked in behalf of an ex cellent report, which S. 1777 would at best duplicate by the Committee for a National Science Foundatio which has had the single aim of assuring the creatio of a Foundation based upon studies already made.

After all this work has been done eight Senator who have had no previous connection with scien legislation and who have offered no evidence of know ing anything about it, ask their 88 colleagues to con sider a $100,000 appropriation to appoint a new com mittee of 50 to make "an initial report and recommen dation to Congress." This has already been don gratis, by the eminent professional men who have con tributed to the final draft of S. 1720.

It is to be hoped that scientists will not leave th sponsors of S. 1777 long in doubt regarding the valu they place upon this bill.

Statement by Senator Willis Introducing a Bill for a National Science Foundation

. . . There is a special reason at this time for the introction of this bill. For over a year, bills providing for deral aid to science in some form have been in Senate mmittees. On October 8, 1945, three subcommittees of ilitary Affairs and Commerce joined in holding hearings proposed legislation to create a National Science Foun-tion. Chief among the bills so considered are S. 1297 d S. 1285, referred to because of their sponsorship as e Kilgore and Magnuson bills.

In the hearings on these bills, the joint subcommittees lled 100 witnesses and printed about 1,000 pages of stimony, but no substantial agreement on a proper bill me from these labors. In the end—toward the close of e last session before the Christmas recess—*a new bill*, 1720, was introduced in an effort to reach an agree-ent to report a bill.

The reason for these difficulties is plain to anyone who ll read the pending bills and the hearings upon them. ndamental division of opinion exists upon the far-aching character of these bills as they relate to political ntrols over science, over the form of administrative ructure as between a directing board or a single head, er patent and national defense features of the bills, er the way in which federal money would be distributed d over the effect of such a distribution on science itself. could continue with these reasons, but it is not my rpose at this time to go into the merits of this legis-tion. I merely wish to point out the situation as we w find it in these committees.

The chief reason for controversy is that the pending lls offer no real difference in approach to this very im-rtant problem. Both of the major bills, S. 1297, S. 85, together with the entirely new bill, S. 1720, coming om the same sponsor of S. 1297 (Mr. Kilgore) involve large government agency, politically responsible and litically controlled. No alternative to the philosophy state-controlled science has been before the joint mmittee.

Scientists who spoke at the hearings had no alternative pproach to consider. Except for the one problem of hether there should be a board or a single head in charge this vast science program, almost no testimony was oduced on the vital question of the administrative ructure and methods of operation of a National Science oundation. The chief question before the witnesses was hether the federal government should aid science; and course most of the witnesses approved the proposal for deral aid. Few of the witnesses considered how this as to be done. Few spoke of the specific provisions of e bills. I doubt if the scientists who appeared (many them eminent men) would be for any bill which means overnment control, political interference, or restrictions the freedom of scientific thought and action. The ending bills do involve those questions very materially t few witnesses turned their opinions in that direction largely because there was no other bill to raise the question of a different approach to federal aid of science.

We are now in this position: that the pending bills have been rewritten and revised many times and no agreement has been reached on any one of them. In these circumstances, an entirely new bill, S. 1720, was introduced a few weeks ago. This new bill makes the same approach to the problem as did the previous bills; and it contains many new and controversial features.

In these circumstances the committees in charge of the hearings must undoubtedly reopen the hearings for further testimony. Certainly the committees could hardly report out a new bill claiming the support of testimony taken on previous and different bills—especially when the new bill raises questions on which controversy exists and on which there is an absence of testimony on the crucial point of administration.

Since a renewal of hearings will and certainly should be undertaken, another means of accomplishing this aid to science should be put before the committee to provide an alternative approach to this problem.

That is the purpose of the bill I am now introducing. The whole subject of federal aid to science is far too important to be settled without exploring all proper methods. The bill I now offer is based on proved American experience which has developed American science from its infancy to the pinnacle of leadership. It safeguards the independence of science at the same time that it provides for federal financial support of science. It eliminates political control far more than does any of the pending bills. It leaves the scientist free to determine the needs of science and yet arranges to correlate science with the development of the nation. It fosters worldwide scientific cooperation.

The bill itself is a simple one. It provides for the formation of an independent corporation by 50 of the most distinguished leaders in the nation, scientists and laymen. With full powers, properly safeguarded, this corporate body of distinguished men and women is entrusted with the responsibility of evaluating the changing needs of scientists, reporting to Congress, and allocating the funds Congress appropriates.

For eighty years the National Academy of Sciences has functioned quietly and efficiently on the same principle. Since 1917, the National Research Council, associated with the Academy, has done likewise. The war record of these two distinguished scientific bodies is worth any Senator's study on the question of federal aid to science. Without the Academy and the National Research Council, the work and achievements of the OSRD, the WPB and other agencies dependent on science would have been severely handicapped. The Red Cross, which as we all know has distinguished itself at home and abroad, in peace and in war, is organized on the same principle as embodied in this bill. Such institutions as the Academy and the Red

Cross are eloquent proof that the principle of an independent body, free of government interference and free of political control, is a sound and desirable one.

Mr. President, that is the principle incorporated into this bill for federal aid to science which I now offer. I ask that it be referred to the Committee on Commerce which has other science aid bills before it. There I hope it will receive proper consideration for the splendid alternative it offers to the present controversies over federal aid to science.

S. 1777

A bill to assist the agencies of scientific and technological education and the development of the Nation and to establish a National Science Foundation:

DECLARATION OF POLICY

SEC. 1. Congress hereby recognizes that the energetic development and application of the Nation's scientific and technological resources are essential to progress and prosperity. The purpose of this Act accordingly is to aid other agencies in advancing the Nation's scientific and technological education and development, and in particular to supplement moneys now and hereafter forthcoming from private sources, by such appropriations as Congress, acting upon the advice of the National Science Foundation, herein created, may make available.

ESTABLISHMENT OF INDEPENDENT OFFICE

SEC. 2. There is hereby created, as an independent agency of the Federal Government, the National Science Foundation, a corporation, the initial members of which shall be fifty (50) distinguished men and women representative of all sections of the Nation, recognized leaders in the fields of fundamental science, social sciences, medicine, engineering, and education, and lay persons of recognized standing in public affairs, selected solely on the basis of established records of distinguished service without reference to any political, social, or religious factors. The President of the United States shall select and appoint these initial members of the Foundation from among nominations requested by him from the National Academy of Sciences for those fields within the province of the Academy and from recognized National organizations in those fields outside the province of the Academy.

SEC. 3. The National Science Foundation shall consist of not more than fifty (50) members, and the said corporation hereby constituted shall have power to make its own organization, including its constitution, bylaws, and rules and regulations; to fill all vacancies created by death, resignation, or otherwise; to provide for the division into classes; to appoint a chief executive officer and a staff and to pay their salaries from moneys that may be available for that purpose; and in general to do all other matters needful or usual in such institution, and to report the same to Congress annually.

SEC. 4. (a) The National Science Foundation shall hold meetings at such times and places in the United States as it may designate, and the Foundation shall examine into and report to Congress annually upon the monetary needs of American institutions devoted to higher education and the pursuit of knowledge in regard to research and training in all departments of science as well as aid by means of scholarships and fellowships in these departments, and disburse such funds as Congress may provide.

(b) In matters relating to the departments of science represented in the National Academy of Sciences (the physical and biological sciences and mathematics including basic medicine and engineering the Foundation shall in discharging its functions request advice from the Academy (an agency incorporated by Congress, March 3, 1863, to advise Government in matters of science and art). With regard to matters outside those fields within the province of the Academy, it shall request the advice of recognized national organizations in the appropriate field. The Foundation, however, shall not be obligated to follow advice so requested if it is contrary to its own judgment.

SEC. 5. The Foundation shall foster the maximum publication and dissemination of scientific discoveries and technical information of scientific value and may publish or arrange for publication of such discoveries and information.

SEC. 6. The Foundation is hereby authorized with the approval of and through the Secretary of State to cooperate in any international research activities consistent with the purposes of this Act and to conclude agreements with foreign governments or agencies thereof facilitating the acquisition, dissemination and exchange of scientific and technical information. The Foundation shall, from time to time, in cooperation with the State Department and other interested governmental agencies appoint from nominees of scientific and professional associations official representatives to accredited international scientific congresses and meetings and defray the expenses of such representatives.

SEC. 7. The National Science Foundation is au-

horized and empowered to receive by devise, bequest, donation, or otherwise, either real or personal property, and to hold the same absolutely or in trust, and to invest and manage the same in accordance with the provisions of its constitution, and to apply said property and the income arising therefrom to the objects of its creation and according to the instructions of the donors: provided, however, that Congress may at any time limit the amount of real estate which may be acquired and the length of time the same may be held by said National Science Foundation.

SEC. 8. Neither the Foundation nor any of its members shall receive any compensation whatever from Congress for any of the services which it performs, but the actual expenses incurred in the discharge of its duties, including travel and subsistence of members in discharge of their duties, may be paid from appropriations which may be made for the purpose.

SEC. 9. Congress shall have the right to repeal, alter, or amend this Act at any time.

SEC. 10. In order to provide for the organization of the Foundation and the making of an initial report and recommendation to Congress there is hereby appropriated the sum of one hundred thousand dollars ($100,000).

News and Notes

Dr. Carroll C. Pratt, professor of psychology on leave of absence from Rutgers University, has been made Ordinarius Professor at the University of Ankara by the Turkish Ministry of Education. This is the second time this rank has been conferred at Ankara.

Col. Walter M. Scott, chemist and authority on cotton textile problems, has been made director of the U. S. Department of Agriculture's Southern Regional Research Laboratory at New Orleans, according to an announcement by Washington officials on 2 January 1946. Dr. Scott, who will assume his new duties about 1 February, succeeds the late D. F. J. Lynch, who directed the laboratory from the time of its establishment until his death a few months ago.

Lt. Herbert S. Bailey, Jr., USNR, has been appointed scientific editor of the Princeton University Press, effective 1 February.

A lecture series, "Recent Advances in Botany," is now being given at the Brooklyn Botanic Garden. Dr. Ray F. Dawson, of the Department of Botany, Columbia University, was the first speaker, on 12 December 1945, his subject being "Grafting as a Method of Study of Drug Production in Plants." On 9 January Dr. F. E. Denny, of the Boyce Thompson Institute, spoke on the "Control of Dormancy in Plants." Forthcoming in the series are: 13 February: "Plants and the Material Basis of Civilization," Dr. E. W. Sinnott, director of Sheffield Scientific School, Yale University; 13 March: "Effect of Light Periods on Flowering," Dr. K. B. Link, horticulturist, Brooklyn Botanic Garden; 10 April: "Plant Viruses and the Nature of Virus Diseases," Dr. B. M. Duggar, University of Wisconsin and Lederle Laboratories.

Dr. Elton F. Paddock has joined the genetics group of the Department of Zoology and Entomology at the Ohio State University, with the rank of assistant professor. He will teach genetics and cytogenetics.

Dr. J. F. T. Young has been promoted to the rank of professor and head of the Department of Physics at the University of Manitoba, Winnipeg, Canada, in succession to Professor Emeritus Frank Allen, the founder of the department, who has retired after 40 years of service with the University.

Dr. Frank Harrison, associate professor of anatomy of the College of Medicine and the School of Biological Sciences of the University of Tennessee, has been appointed professor of anatomy and chief of the Division of Anatomy. He will assume the post on 1 April 1946, succeeding Dr. K. B. Corbin, who at that time will become associated with the Mayo Clinic.

Recent Deaths

Dr. Edwin Stephen Goodrich, 77, died in his home at Oxford on 6 January. He was a Fellow of Merton College, Oxford, and also Linacre professor of zoology and comparative anatomy at the University Museum, Oxford. Dr. Goodrich received the Linnean Gold Medal in 1932 and the Royal Medal of the Royal Society in 1936. He was the author of several works on zoology.

Dr. C. E. McClung, 75, emeritus professor of zoology and former director of the Zoological Laboratory, University of Pennsylvania, and acting head of the Department of Biology at Swarthmore College, died suddenly on 17 January in Swarthmore, Pennsylvania.

Technical Papers

Characterization of Pectin

CLAUDE H. HILLS and RUDOLPH SPEISER
Eastern Regional Research Laboratory,[1] Philadelphia

The molecule of the natural high polymer, pectin, is composed principally of anhydrogalacturonic acid residues, partially methyl esterified and linked together to form a long chain. Nongalacturonide materials, galactan and araban, may constitute one-third or more of the weight of the pectin. As has been shown by Schneider and Bock (*3*), the characteristic properties of pectin—gelation, film formation, and high viscosity in dilute solution—derive from the polygalacturonide chain; the nongalacturonide constituents or "ballast materials" act mainly as diluents.

In characterizing pectin by chemical means it has been the custom to give the ester content, computed as methoxyl and expressed as per cent by weight of the whole sample. Alternatively, the related quantity, neutralization equivalent, has been used for the same purpose. It is the object of this communication to demonstrate that because of variability in the proportion of nongalacturonide material neither the weight per cent of methoxyl nor the neutralization equivalent is adequate for the characterization of pectin, and to show that the properties of pectin are better described by the galacturonide content and the degree of esterification of the galacturonide chain.

Recently considerable interest has developed in low-ester pectin. De-esterification progressively increases the acidic nature of pectin and hence its reactivity with metallic ions. Beyond a certain stage in the de-esterification, the pectin is able to form stable gels with polyvalent cations such as calcium. These gels have promise of commercial importance.

It has not been recognized previously that the galacturonide content of a low-ester pectin may be greatly influenced by the method of de-esterification. Fig. 1a shows that in de-esterification by acid the methyl ester groups and the nongalacturonide materials are removed at approximately the same rate, while in enzyme de-esterification (Fig. 1b) the nongalacturonide content is reduced only slightly. The methoxyl content and neutralization equivalent of low-ester pectins produced by these two methods are not, then, in general comparable, because the pectins contain different amounts of diluent.

On prolonged acid treatment the nongalacturonide content of the pectin sample represented in Fig. 1a was reduced to 0.9 per cent. The corresponding average residue weight is 178 and thus approaches closely the theoretical limit of 176, the residue weight of

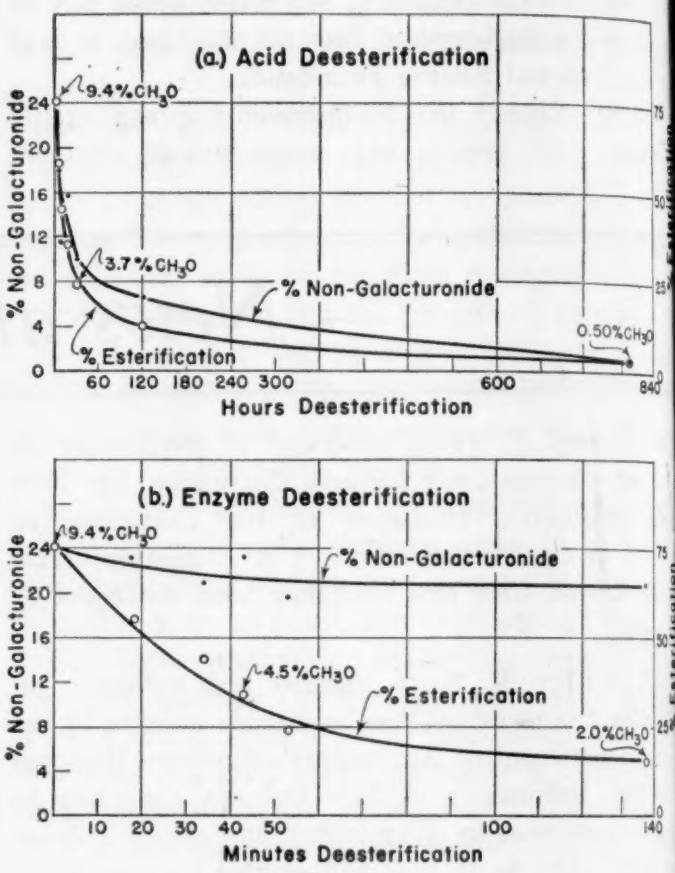

FIG. 1

anhydrogalacturonic acid. The fact that this material was of high molecular weight (at least 30,000 as indicated by viscosity and gel formation) means that probably none of the nongalacturonide constituents are situated in the pectic acid chain. This confirms the conclusion reached by Schneider and Bock (*3*) from entirely different experiments that the main pectin chain consists exclusively of anhydrogalacturonide units.

As stated above, a characteristic property of low-ester pectins is the formation of ionic-bonded calcium gels. The extent of de-esterification necessary for gel formation with calcium ions cannot be defined accurately by either the neutralization equivalent or the methoxyl value, since both quantities are affected by variation in the nongalacturonide materials present. This fact is illustrated by the data in Table 1. Sample A, a non-de-esterified pectin, did not form a stable calcium pectinate gel, although it had a lower methoxyl value than sample B-1, which did form a gel. This anomaly is explained by the difference in the per cent esterification of the two samples. It may

[1] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

observed that calcium pectinate gels containing 35 per cent sugar are formed only when the degree of esterification of the polygalacturonide chain is less than 50 per cent.

Data for samples A and A-1 show that by removal of nongalacturonide material the methoxyl value and the neutralization equivalent may be changed greatly, while the degree of esterification is reduced only

TABLE 1

DATA CHARACTERIZING TWO SERIES OF ACID—DE-ESTERIFIED PECTINS

Sample No.	Description	Ca-pectinate gel formation*	Per cent esterification	Per cent CH_3O	Neut. equiv.	Per cent galacturonide
A	Commercial apple pectin	None	68.0	6.57	990	57.8
A-1	Sample A purified†	None	66.7	8.06	769	71.1
A-2	Sample A acid de-esterified	None	50.6	6.61	476	78.3
A-3	Sample A acid de-esterified	Strong	38.5	5.23	370	80.1
B	Purified apple pectin†	None	74.2	9.36	952	76.0
B-1	Sample B acid de-esterified	Weak	45.2	6.78	391	85.7
B-2	Sample B acid de-esterified	Strong	24.2	3.70	269	89.1

* Calcium pectinate gels, containing 35 per cent sugar, prepared by method of Hills, White, and Baker (Hills, C. H., White, J. W., Jr., and Baker, G. L. *Proc. Inst. Food Tech.*, 1942, 47–58).

† Purified by dissolving in water, adding 5 per cent conc. HCl by volume, immediately precipitating with ethanol, and washing with ethanol until free of chlorides.

slightly. Clearly, the increase in the jelly grade of pectins upon mild acid de-esterification observed by Baker and Goodwin (*1*) may be caused in part by the removal of inactive constituents and the consequent increase in galacturonide content.

The degree of esterification and the galacturonide content may be calculated readily from the methoxyl value and titration data. Each anhydrogalacturonide residue in the chain may be considered to contain either a free carboxyl or a methyl-esterified carboxyl group.[2] The number of moles of free carboxyl groups (N) per gram of pectin may be determined from the alkalinity of the ash and the amount of alkali required to titrate an aqueous solution of pectin to pH 7.5 (*4*). The number of moles of methyl-esterified carboxyl groups may be determined by methyl ester analysis (*2*) and the formula

$$Z = \frac{\text{wt. per cent } CH_3O}{3100}$$

From these two quantities one may compute the per cent galacturonide, the per cent nongalacturonide, the neutralization equivalent, the per cent esterification of the galacturonide chain, and the average residue weight by the relations

$$\text{Per cent galacturonide} = (176\,N + 190\,Z) \times 100$$

$$\text{Per cent nongalacturonide} = 100 - \text{per cent galacturonide}$$

$$\text{Neutralization equivalent} = \frac{1}{N}$$

$$\text{Per cent esterification} = \frac{Z}{Z+N} \times 100$$

$$\text{Average residue weight} = \frac{1}{Z+N}$$

In view of these considerations it is suggested that, instead of per cent methoxyl by weight, the per cent galacturonide and the per cent esterification of the galacturonide chain be used in the characterization of pectin.

[2] The close agreement between the decrease in methyl ester groups and the increase in carboxyl groups observed on de-esterification of pectin indicate that, for the purpose of calculation, it is valid to consider that all the ester groups are methyl. In any case, if the araban or galactan occurred as ester groups, the decrease in the total carboxyl content would be negligible because of their high molecular weight.

References

1. BAKER, G. L., and GOODWIN, M. W. *Del. Agric. Exp. Sta. Bull.*, 1941, No. 234.
2. HILLS, C. H., OGG, C. L., and SPEISER, R. *Ind. eng. Chem.* (Anal. ed.), 1945, **17**, 507.
3. SCHNEIDER, G., and BOCK, H. *Ber.*, 1938, 71B, 1353.
4. SPEISER, R., HILLS, C. H., and EDDY, C. R. *J. phys. Chem.*, 1945, **49**, 328.

Inhibition of Growth of *Mycobacterium Tuberculosis* by a Mold Product—the Effect on Pathogenic Human Tubercle Bacilli [1,2]

ISADORE E. GERBER and MILTON GROSS

Hudson County Tuberculosis Hospital, Jersey City

A mold product capable of inhibiting the *in vitro* growth of a rapidly proliferating nonpathogenic strain of *M. tuberculosis* was described in a previous report (*1*). The present study is concerned with the *in vitro* activity of this mold product against pathogenic human tubercle bacilli.

For convenience the material has been named, temporarily, mycocidin and a working unit of activity has been established. The strength of a mycocidin preparation is determined as follows: A standard culture is prepared consisting of a 5-day-old pellicle of the nonpathogenic strain of *M. tuberculosis* var. *hominis* (American type culture collection No. 607) on Long's synthetic liquid medium. The standard inoculum, which measures approximately 2 × 2 mm., is taken from the periphery of this pellicle. With some experience nearly similar fragments are usually obtainable. Test tubes of 1 in. in diameter containing 5 ml. of Long's synthetic medium are set up in series and mycocidin is added in varying concentrations. The final volume is made to 6 ml. The inoculum is floated

[1] From the Laboratories of the Hudson County Tuberculosis Hospital, Jersey City, New Jersey.

[2] The authors wish to acknowledge thankfully the accurate and capable assistance of Lyetta Yogman.

on the surface of the medium and the tubes are incubated at 37.5° C. for 5 days. The extent of growth of the inocula is recorded daily and compared with controls. A unit of mycocidin (M-unit) is defined as that amount of the preparation of the mold extract per milliliter of Long's synthetic medium which will completely inhibit the growth of the standard inoculum.

TABLE 1

Experiment number	Extract number	Concentration range (M-units per ml. Long's medium)	Strain of tubercle bacillus	Inoculum	Length of exposure of tubercle bacilli to mycocidin in Long's medium	Treated bacilli replanted and incubated for:	Minimal concentration necessary for complete inhibition (M-units per ml. Long's medium)
1	30	1.70 –2.66	RES	Large clumps	7 days	57 days	1.700
2	30 PD	0.13 –1.30	RES	Large clumps	7 days	44 days	0.515
3	30 PD	0.125–1.25	RES	1 mg. in suspension	7 days	50 days	0.625
4a.					18 hours	60 days	0.833
b.	34	0.20 –2.00	RES	1 mg. in suspension	3 days	58 days	0.625
c.					5 days	56 days	0.415
5	34	0.20 –2.00	CS	Large clumps	7 days	55 days	0.625

The human pathogenic tubercle bacilli employed in this experiment consisted of two strains which were isolated from patients with far-advanced pulmonary tuberculosis. The bacilli were grown on Petragnani's solid medium. Both strains are highly pathogenic for guinea pigs as evidenced by the fact that an inoculum of 0.0001 mg. of the bacilli suspended in normal saline and injected into the groin of guinea pigs produces diffuse miliary tuberculosis within 6 weeks.

The pathogenic human tubercle bacilli were treated with the mold product in the following manner: Tubes containing 5 ml. of Long's synthetic medium were set up in series. To one group mycocidin in varying concentrations was added. The other group served as a control. The final volume was made to 6 ml. Clumps or suspensions of tubercle bacilli were added to the tubes containing the extract as well as the controls. These were then incubated for periods varying from 18 hours to 7 days. The bacilli were centrifuged, washed with saline, recentrifuged, and resuspended in saline. The organisms were then tested for viability either by culturing on Petragnani's solid medium or by inoculation into guinea pigs.

The culture experiments are summarized in Table 1. As will be noted in Experiments 1, 2, and 5, the tubercle bacilli used consisted of clumps weighing from 1 to 2 mg. exposed to mycocidin in the Long's synthetic medium for a period of 7 days. The growth of the recultured bacilli was observed weekly, the final reading being made at periods of 44 to 57 days. Experiment 1 was a pilot experiment, and it soon became evident that more than the minimal amount of mycocidin necessary for complete inhibition of the organism had been used. In subsequent experiments, lower concentrations of mycocidin at graded intervals were employed. The minimal amount necessary for complete inhibition of growth was found to be approximately 0.515 M-unit per ml. of liquid medium for the RES strain and 0.625 for the CS strain. In Experiment 3, suspensions of organisms instead of clumps were employed. These suspensions were made by grinding a weighed quantity of bacilli in a mortar with saline containing several drops of bile. A final concentration of tubercle bacilli in suspension in saline of 1 gram per cent was made. One-tenth of a milliliter, equivalent to 1 mg. of bacilli, was added to each test tube containing the liquid medium with varying concentrations of mycocidin. It was found here, also, that the minimal concentration necessary for complete inhibition was 0.625 M-units per ml. In Experiment 4, the technique was similar to that of Experiment 3. However, the period of incubation was varied. Groups of tubes containing the extract and comparative controls were incubated for 18 hours, 3 days, and 5 days. As can be seen from the table, the minimal concentration necessary for complete inhibition was inversely proportional to the length of exposure of the tubercle bacilli to the mycocidin.

Cultures of the controls in all the preceding experiments showed active growth within 21 days, whereas those of the bacilli exposed to as little as

0.125 M-unit per ml. were still negative. At the time of the final reading all controls showed active, prolific growth, whereas all the cultures of the organisms treated with the minimal effective concentrations were negative. Bacilli that had been treated with less than minimal effective concentrations grew out slowly, the rate of growth being inversely proportional to the concentration of mycocidin to which they were exposed.

The animal experiments performed are summarized in Table 2. One milligram of the organisms of the RES strain in suspension was exposed to mycocidin in Long's liquid medium in the manner described above for periods of 18 hours, 3, 5, and 7 days at 37.5° C. The centrifuged and washed organisms were resuspended in saline and amounts equivalent to 0.1 and 0.5 mg. were injected into the groin of guinea pigs weighing 400–500 gms. Twenty-five animals were used. As can be seen from Table 2, when the organisms were exposed for a period of 3, 5, or 7 days to a concentration of 1 or 2 M-units per ml. and were injected into guinea pigs, the animals failed to develop tuberculosis. When killed 7 or 8 weeks later they were entirely negative on post-mortem examination. With lower concentrations and insufficient exposure, there was only partial inhibition of the bacilli as evidenced by the mild to moderate tuberculosis observed in the animals injected with these bacilli. All control animals showed far-advanced miliary tuberculosis.

TABLE 2

Extract number	Length of exposure of 1 mg. tubercle bacilli to mycocidin in Long's medium	Concentration of mycocidin in Long's medium (M-units per ml. Long's medium)	Number of guinea pigs	Mg. tubercle bacilli injected into guinea pig	Result
		0 (Controls)	4	0.1	All animals died within 28–35 days with diffuse miliary tuberculosis.
30 PD	7 days	1.0	4		One animal died after 6 days of pneumonia. Two were killed at the end of 30 and 51 days, respectively. One animal still alive at 127 days. No evidence of tuberculosis in any animal.
		0	2		One animal died after 48 days. The other was killed after 54 days. Both animals had diffuse tuberculosis.
	18 hours	0.2	2	0.5	One animal died after 46 days. The other was killed after 54 days. Both animals had diffuse tuberculosis involvement but less than controls.
		2.0	2		Both animals killed after 54 days—moderate tuberculosis present in one animal; other entirely negative.
		0	2		Both animals killed after 52 days—both extensive tuberculosis.
34	3 days	0.2	2	0.5	Both animals killed after 52 days—minimal tuberculosis in all viscera—early productive type lesions.
		2.0	2		Both animals killed after 52 days—both animals negative.
		0	1		Killed after 58 days—very extensive tuberculosis.
	5 days	0.2	2	0.5	Killed after 58 days. Liver and lungs normal. Focal tuberculosis in spleen and inguinal lymph node.
		2.0	2		Killed after 58 days—both animals negative.

Cultural studies and animal inoculations indicate that the mold extract, mycocidin, is both bacteriostatic and bactericidal for the human tubercle bacillus. After exposure to adequate concentrations of mycocidin, the bacilli fail to grow out when replanted on solid medium, and lose their ability to produce tuberculosis in guinea pigs. Since the treated bacilli are thoroughly washed, this cannot be due to adherent mycocidin. In concentration less than minimal, the bacteriostatic property of mycocidin is evidenced by the fact that when the bacilli are replanted on solid medium the rate of growth is slow in comparison to the controls and is inversely proportional to both the length of exposure and the quantity of mycocidin. It was found that 0.5 to 0.6 M-unit per ml. was necessary for bactericidal effect upon 1 mg. of the pathogenic strain of human tubercle bacilli. This would indicate that the pathogenic strains of human tubercle bacilli used in these experiments are about twice as sensitive to the effects of mycocidin as the nonpathogenic variety.

Further experiments are continuing on the isolation and purification of the active principle. The activity of mycocidin against other organisms is also being investigated.

Reference

1. Gerber, Isadore E., and Gross, Milton. *Science*, 1945, 101, 616–617.

In the Laboratory

Pulsating Perfusing Apparatus

J. A. Long

University of California, Berkeley

In view of the fact that significant results have been obtained in the perfusing of the pancreas of the rat with whole rat blood, it seems worth while to present a brief account of the apparatus used, which is an improvement over the one described in 1939 (*1*).

This new apparatus is larger than the older one, differs in form and proportions, and has certain entirely new additions, yet embodies most of the former features of construction. It consists of several pieces of thin plate glass, held together by bolts (not shown in the figure), to which are attached all

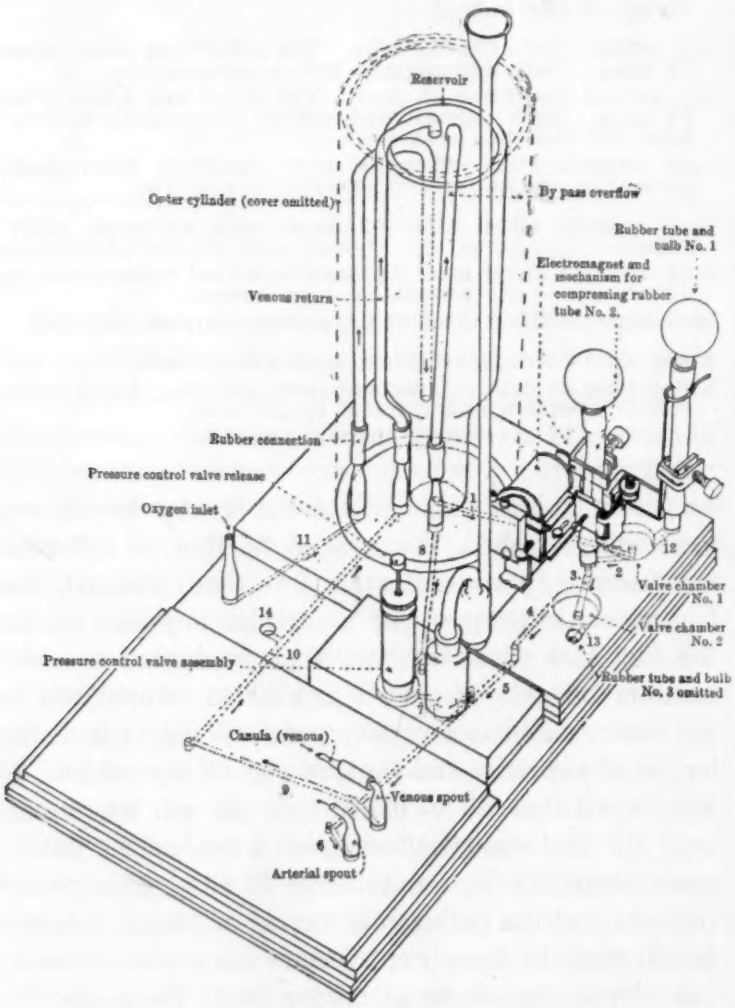

FIG. 1

the other parts. The blood "vessels" for the most part lie within the plates and consist of small, drilled holes and half-round channels cut in one plate and covered by another (No's. 1 to 11). Channel 1 connects the reservoir (which also serves as a respiratory chamber) with the pump; 4, 5 and 6 run from the pump to the arterial spout, cannula, and artery of the organ to be perfused; 9 and 10, as veins, carry blood from the venous cannula and spout to the vertical venous return tube, which discharges dark, venous blood over ¼-in. glass balls occupying the upper wide portion of the reservoir which is kept filled with oxygen. The blood, thus trickling down over the balls becomes bright red and is drawn again into the pump.

The essentials of the pump are: two chambers (large holes bored out of the middle plate of the three of the pump); glass valves (not shown), one sitting over the opening in the bottom of each chamber; connecting channels (2, 3, etc.); and rubber tube and bulb No. 2. The piston is the fluid which moves up and down in the tube as the tube is alternately compressed by the electromagnet and released to expand by its own elasticity. The action of the pump is that of a simple pump forcing blood in the direction of the arrows.

To obtain sufficient pressure the pump must deliver considerably more blood than can pass through the organ. The excess arterial blood is allowed to escape as it passes along channel 5, through side channel 7 on to 8, and finally through the by-pass overflow to the top of the reservoir. Between 7 and 8 the blood must lift a valve (in the pressure-control valve assembly) which is held down by an adjustable spring. The stronger the spring, the more the pressure is built up in channels 4 to 6. The latter is recorded by the mercury manometer at the end of another side channel off the point of junction of 5 and 7. An automatic release apparatus (not shown) prevents any emergency excess pressure. The pump is capable of delivering pressures up to 200 mm. of mercury.

The form of the reservoir permits the use of small quantities of blood, the minimum being 5 to 10 cc. blood from a rat donor of 450 to 500 grams being sufficient for one experiment.

The specimen chamber is not shown. This varies in shape with the organ under investigation. It is made of plaster of Paris, contains a nichrome heating coil, a thermostat, and thermometer, and will be described in some detail in connection with the results of experiments. The form of the whole apparatus was planned so that the specimen in the chamber can be examined under a microscope.

Reference

1. Long, J. A. *Univ. Calif. Publ. Zool.*, 1939, **43**, 211-216, Plate 25.

An Apparatus for Determining the Respiratory Volume of Large Aquatic Birds

EUGENE DEHNER, O.S.B.
Cornell University

The apparatus shown in Fig. 1 is designed to adapt the oxygen dilution method of clinical lung-volume determination to the measurement of the total respiratory volume of various aquatic birds. In this method, the respiratory gases of the subject are mixed, through a mouthpiece, with a known quantity of oxygen, and the lung volume is calculated by the equation:

(1) Lung Volume (Respiratory Volume) =

$$VO_2 \times \frac{\%N_2 - a}{79.1 - \%N_2}$$

where VO_2 is the volume of oxygen in the apparatus used, a is a correction for impurities in this oxygen, 79.1 is the approximate percentage of nitrogen in the respiratory gases, and $\%N_2$ is the percentage of nitrogen found in the mixed gases (*3*).

The spirometer, S (Fig. 1), has a bell adequate to the tidal air of the bird being tested. Two interchangeable bells, with capacities of 90 and 140 cc.,

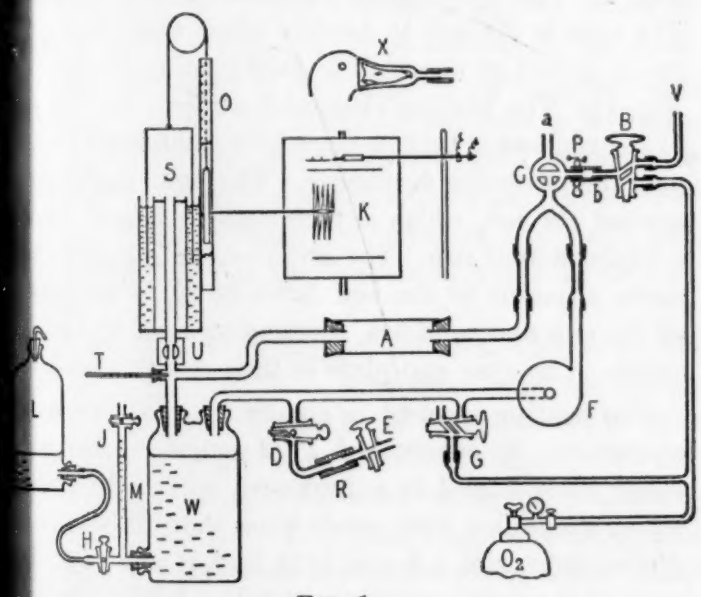

FIG. 1

and calibrated to equal 1.33 and 2 cc./mm., respectively, on the scale, O, and the record, K, have been used. The technique of Herrald and McMichael (*2*) is employed by keeping constant during a test the volume of the bell, as read on K, through the addition of oxygen at stopcock G. Tidal air and rate of ventilation as well as spirometer volume are recorded on K. The centrifugal fan, F, 5 cm. in diameter, circulates the gases in the apparatus. The water level in the 500-cc. Woulff bottle, W, calibrated to the scale, M, is adjusted with the leveling bottle, L. The chamber, A, contains 16 grams of dry, No. 4 mesh sodium calcium hydrate for absorbing carbon dioxide. The bore of the three-way stopcock, C, is 5 mm. and that of the rubber and glass tubing in the circuit is 8 mm. Negative pressure is exerted through the tubing, V. The temperature of the apparatus is read on the thermometer, T.

The apparatus is rinsed and filled with oxygen, as follows: The water level in the bottle, W, is adjusted to zero on the scale, M, and the spirometer bell, usually removed between tests, is replaced in the water seal, while stopcocks C and B are in the position shown. Then, with the fan, F, running, enough oxygen (90–140 cc.) to fill the bell is alternately admitted and withdrawn, about 25 times, by manipulating stopcock B.

The dead space (here 180.0 cc.) may be determined by filling the apparatus with oxygen as above, setting the spirometer bell at zero, and mixing the oxygen with a measured volume of atmospheric air from an aspirator bottle attached at *a* of stopcock C. The mixture is analyzed for percentage of nitrogen, as below, and the dead space calculated by applying equation (1) inversely.

In preparing for a test, sufficient oxygen is added to the dead space to make the total VO_2 of the apparatus equal to the estimated volume of the bird's respiratory system. This is done by opening stopcock B, raising the spirometer bell from zero to the desired point or points on scale O and allowing the measured oxygen to flow into the bottle, W, by opening stopcock H. The bell is set about one-third above zero on scale O, stopcock C is given a half-turn from the position shown, and stopcock B is removed from the coupling, *b*.

A bird is prepared by first tying the tibiotarsal joints and resting the animal on the operator's lap. A glass hood, X, is slipped over the bill and sealed to the bird's head with a rubber flange, prepared from a No. 7 latex balloon. The hood is then attached to the apparatus at *a* on stopcock C, so that the bird breathes air at *b*. The bird is cut into the apparatus at the inspiratory phase, by giving C a quarter-turn counterclockwise. When the fan, F, is started, the spirometer bell falls, and the points on the record rise regularly as oxygen and carbon dioxide are absorbed. Stopcock G is then opened to admit just enough oxygen to restore the points on the record to the original level for the remainder of the test.

A volumetric test, lasting 4 to 8 minutes, is terminated at the inspiratory position by turning stopcock C to the starting position. The bird is now prevented from breathing by the pinchcock, P, which has been clamped on the coupling, *b*, during the mixing process, and while in this condition, samples are quickly drawn

from the interclavicular and right abdominal air sacs, through No. 23 Yale needles into 2-cc. glass syringes, oiled and freed of air. Samples of the spirometer mixture are drawn similarly through the rubber tubing at R, after first rinsing some of the mixture through stopcocks D and E while valve U is closed and water flows from the bottle, L, into W. All samples are analyzed immediately for percentage of nitrogen, using Bayer's technique (*1*) with Krogh's pipette.

The respiratory volume (lungs, air sacs, and trachea) of the bird is calculated using equation (1). The figure 79.0 for the normal percentage of nitrogen in the air sacs has been found suitable for this calculation. The final VO_2 of the apparatus is measured accordingly if the points on the record, K, are slightly above or below their starting place.

Corrections for difference in temperature and the vapor pressure of water are added to the calculated respiratory volume. The dead space of the hood, X, is subtracted from the corrected volume. No correction has been made for the error, estimated at less than 2 per cent, due to the diffusion of nitrogen from the blood and tissues of the bird during a test.

Although normally the ventilation of the various air sacs differs greatly, samples taken from the air sacs during a test have been found to check, as a rule, within .5 per cent with those from the spirometer. The apparatus has been used with gulls, and with mallard, black, redhead, and wood ducks. Using mallards and wood ducks, we have tested the duplicability of observations with the apparatus and found the coefficient of variability of test runs made on the same duck, the same day, to be less than 6 per cent and that of runs made on the same duck on different days to be less than 8 per cent.

References

1. BAYER, FRITZ. *Gasanalyse; neuere Methoden der Arbeitspraxis unter Berücksichtigung der physiologischen Wirkungen der Gase.* Stuttgart: F. Enke, 1938. Pp. 108–112.
2. HERRALD, F. J. C., and MCMICHAEL, J. *Proc. roy. Soc. Lond.*, 1939, **126 B**, 491–501.
3. PETERS, JOHN P., and VAN SLYKE, DONALD D. *Quantitative clinical chemistry.* (Vol. II.) Baltimore: Williams and Wilkins, 1932. Pp. 217–228.

A New Sterile Technic for Preparing Agar Cup-plates

JOHN E. CHRISTIAN and MILTON L. NEUROTH
Purdue University School of Pharmacy

The agar cup-plate method has found considerable application as a test for bacterial inhibitory properties of many substances. Examples of substances which have been tested by this method are liquid products, ointments, dusting powders, catgut, creams, and suppositories (*1*). The test, however, has been greatly limited by the difficulty encountered in preparing, in a sterile manner, suitable uniform cups in the agar. Two standard methods have been used: (1) Before the agar cools, a depression or cup is made in the medium by standing a sterile, flat-bottomed, glass tube in the liquified agar. When the agar is hard, the glass tube is removed by slightly twisting and pulling and at the same time inserting a sterile wire down the side of the tube for the introduction of air in an attempt to prevent the cracking of the agar. (2) The agar is allowed to harden and then a disk is cut out of the agar by means of a suitably sized sterile cork borer. Both these methods are very cumbersome, and a uniform cup without cracked edges is difficult to obtain. Contamination of the plate is also very common in these procedures, since the lid of the plate must be removed. Still another operation is necessary in these methods—that of placing one or two drops of melted agar in the cup to seal cracks of crevices formed.

A simple new technic is proposed for the preparation of uniform agar cups in a sterile manner. Sterile, flat-bottomed, pyrex glass rods, the diameter of which determines the size of the agar cup, are placed in the liquid agar in the Petri dish, as is shown in Fig. 1. The pyrex glass rods are 10 mm. in length. The agar is allowed to harden, after which each glass rod is heated by means of a small heating element (see Fig. 1). The heating element is slipped over the end of the rod and is held in place by a small glass plunger operated with the forefinger. The agar melts evenly around the rod, which is then easily removed, leaving a uniform agar cup. The small amount of agar which melts adjacent to the rod flows down to the bottom of the cup and solidifies, forming an agar seal at this point. The agar cup-plate is then ready for use.

The heating element is simple in construction and operation. It consists of a 22-gauge chromel resistance wire, wound in a four-turn spiral, the ends of which are sealed with pyrex glass onto the outside of a glass tube with a 6-mm. O.D. and 14 cm. long. The ends of the resistance wire extending beyond the glass seal are attached to an ordinary extension cord held in place on the glass tubing by a tight wrapping of asbestos cord. The temperature of the wire spiral is controlled by plugging the extension cord into a variable resistance transformer; 8 to 10 volts produce a suitable temperature. The plunger consists of a 4-mm. pyrex glass rod which will slip inside the glass tubing. By manipulation with the forefinger the plunger is pressed against the side near the top of the glass rod standing in the agar. At the proper moment the glass rod may be lifted from the agar to form a uniform cup.

Four such cups are made in the agar of each Petri dish. Into one cup is placed a control preparation which contains no active material. Various dilutions of the preparation containing active material are

FIG. 1

placed in each of the other cups. In the case of liquid preparations 0.10 cc. is run into the cup by means of a sterile syringe or pipette; if an ointment is involved, 0.50 gram is placed in each cup. A pyrex glass tube, graduated and drawn down on one end to a 2-mm. opening, with a glass rod plunger, is used to introduce the solid or semisolid material into the cups. The graduated tube is filled by inserting the small end into the preparation, then carefully applying vacuum on the other end.

Two methods are available for introduction of the test organism: (1) The base agar may be seeded before pouring into the Petri dish, the glass rods being set and removed as previously described. (2) The method adopted for routine testing of solid materials by the authors has been that of setting and removing the glass rods from sterile base agar. After the preparation has been placed in the cup, a layer of inoculated agar is poured over the base. Twenty cubic centimeters are used as the base layer, and 5 cc. of inoculated agar are poured on top. The inoculated agar consists of 2 cc. of a 16- to 18-hour beef broth culture of *S. aureus* placed in 100 cc. of melted agar. The layer of inoculated agar, when solidified, seals the preparation in the cup. The Petri dish may then be placed in the incubation oven in an inverted position, thus eliminating any condensation of moisture. The plates are incubated at 37° C. for 16 to 18 hours. Fig. 2 shows the results of a test plate. The zones

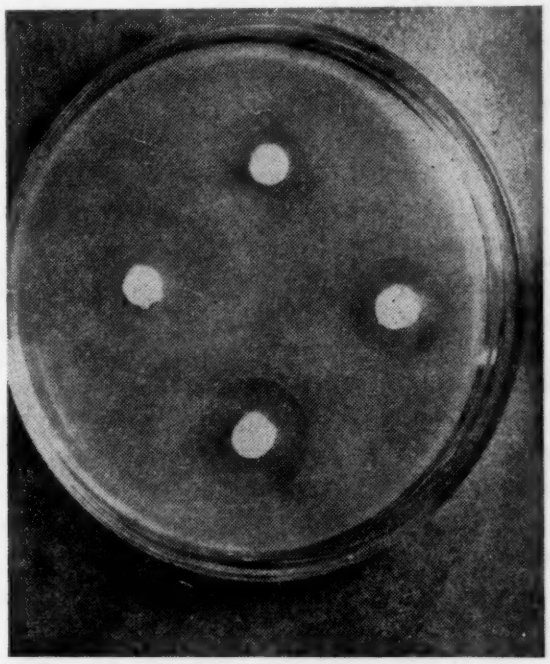

FIG. 2

of inhibition are very uniform for any specific concentration and vary in size according to the degree of dilution. Table 1 indicates the uniform results obtained on a set of plates.

TABLE 1

ZONES OF INHIBITION IN MILLIMETERS

Plate number	Ointment base	Base containing 1 unit penicillin/gram	Base containing ½ unit penicillin/gram	Base containing ¼ unit penicillin/gram
		mm.	*mm.*	*mm.*
1	no zone	20.50	17.50	13.50
2	"	20.50	17.50	12.50
3	"	20.75	17.50	14.00
4	"	20.75	17.75	13.50

The method described has been used with good success for the routine testing of ointments and creams containing penicillin and has been found to have many advantages over other technics used for this purpose. The heating element for this new technic is inexpensive and easy to manipulate.

Reference

1. ZINSSER, H., and BAYNE-JONES, S. *Textbook of bacteriology.* (8th ed.) New York: D. Appleton-Century, 1939. Pp. 956, 957.

Letters to the Editor

Information for B. and T.

Relative to the letter of B. and T. (*Science*, 1946, 103, 26), the following observation is submitted. Five brothers, all the boys in one family, are all in *Who's Who in America*, 1938–1940. They are Franklin, Henry Clapp, James Morgan, John Harvey, and Welk Alvord Sherman. All were born at Ash Grove, Virginia, and probably attended the same school.

W. O. R.

Department of Agriculture

In the middle 1880's three brothers, William C., E. Henry, and Gustav F. Ruediger attended a one-room country school in School District No. 1, Town of Milton, Buffalo County, Wisconsin. I think you will find these names in the fourth and fifth editions of *American Men of Science*.

E. HENRY RUEDIGER, M. D.

Florida State Hospital
Chattahoochee, Florida

Since the chance of such a coincidence is rather small, B. and T. (*Science*, 1946, 103, 26) wish to know whether any one-room country school other than the one they mention has ever numbered among its alumni two starred scientists. At the end of the 1870's, two brothers, who are both starred in *American Men of Science*, simultaneously attended such a school near Hutchinson, Minnesota. They graduated as classmates from a university in which eventually both served as professors of physics.

Z.

New Haven, Connecticut

In reply to "Information Please" (*Science*, 1946, 103, 26) the following case may be cited: In the later 1870's and early 1880's two boys, born in farmhouses about a half a mile apart and with only two months' difference in their ages, attended, when they became of school age, a one-room country school in Rhode Island. One of them had most of his schooling up to fourteen years of age in that place. When nearly nine years old he was in a graded school for five months, and in another one-room school for seven months, then back to his earlier school. The other boy was in that one-room school during at least two different periods, but for a number of years he attended a graded school in another township. Ultimately, these two went to different colleges, and their careers have been in many respects quite different, but for thirty years or more they have been listed in *Who's Who*. While, therefore, there are many dissimilarities between the early educational advantages of these two men and the ones mentioned in *Science*, the elements of likeness may be sufficient to warrant this note.

One feature that deserves mention is that the teacher in the one-room school during the last three years in which one of these boys attended (and part of that time the other boy was a pupil there) had had a wide experience. He had been a United States consul or vice-consul, in Brazil or Argentina, and had traveled somewhat in Europe. He therefore had a much wider outlook upon life than most teachers in such schools. How much effect this had upon one of the writers, he is not prepared to say. He was out of school entirely from fourteen to twenty-one, but a remark the teacher made when this boy left school at fourteen—"You ought to go on to college"—lingered and may have shaped somewhat his later scholastic career.

T. and W.

Brooklyn, New York

What Can You Do About It?

In *Science*, 1946, 103, 59, Mr. L. J. Thomas suggests that the AAAS take the lead in getting the public more acquainted with the impending dangers of the atomic bomb. The bomb is indeed the most urgent government problem, and an enlightened public is needed. The AAAS should also be able to exert political pressure in this matter. The suggestion that the AAAS take the lead has my full support.

KARL HEYMAN

10 Crestmont Road, Montclair, New Jersey

Announcement

The paper entitled "Physiological comparison of two strains of penicillium," by Robertson Pratt and Jean Dufrenoy, published in *Science*, 1945, 102, 428, contained information obtained under a classified contract between the OSRD and Cutter Laboratories which, in justice to other contractors in the same field, should not have been released. The manuscript of the paper was submitted to the office of the Committee on Medical Research and received official approval for publication. Hence, neither the authors of the paper nor Cutter Laboratories can justly be criticized for this error.

A. N. RICHARDS, *Chairman*
Committee on Medical Research, OSRD

Washington, D. C.

Reversal in the Winter Flounder

Dr. E. W. Gudger's note on reversal in the winter flounder, *Pseudopleuronectes americanus* (*Science*, 1945, 102, 672–673) recalls to mind an additional example of this rare phenomenon.

While shore-seining with Dr. U. B. Stone and Mr. Mark A. Hall in Shinnecock Bay, one mile south of West Tiana, New York, 28 July 1938, we took a single, "left-handed" winter flounder among several hundred normal individuals. My field notes indicate that all speci-

mens were small, and, if I remember correctly, the one left-handed individual was approximately three inches long. The specimen was made a part of the New York State Conservation Department collection and is presumably preserved at the New York State Museum at Albany, New York.

It is of interest to note that of the four recorded instances of reversal in this flounder, two specimens have been taken in Shinnecock Bay.

S. C. BISHOP

University of Rochester

The Coloration of Acid Earths Caused by Vitamin A

In some recent issues of *Science* there appeared an interesting discussion concerning the specificity and the history of the intense blue coloration given by vitamin A solutions on acid earths (A. Lowman, *Science*, 1945, 101, 183; H. R. Kreider, 1945, 101, 377; L. Zechmeister and A. Sandoval, 1945, 101, 585; G. G. Mayer and H. Sobotka, 1945, 101, 695; *cf.* P. Meunier, *C. R. Acad. Sci., Paris*, 1942, 215, 470). It was pointed out by Mayer and Sobotka that the observation of this reaction goes back to the year 1939, when it was described by A. Emmerie and C. Engel (*Rec. trav. chim. Pays-Bas*, 1939, 58, 283). Actually these investigators were not the first ones who observed the reaction mentioned. In 1927 K. Kobayashi and K. Yamamoto (*Chem. Zentralbl.*, 1928, 22, 2397; *cf. Mem. Fac. Sci. Eng., Tokyo*, 1927, 4, 23) reported that vitamin A-containing materials, like cod liver oil, give intense bluish or greenish reactions on Japanese clay, Florida earths, or fuller's earth if a benzene or carbon tetrachloride or carbon disulfide solution is applied. They also correctly attributed this reaction to the vitamin A content of the materials investigated.

HENRY M. ESPOY

Van Camp Laboratories
Terminal Island, California

Preservation of Biological Specimens With Clarite X

A large number of papers have appeared on the preservation of animals by methacrylate resins, but the methods used are difficult and expensive. Very few experiments seem to have been made using other plastics or resins. M. D. Wheatley (*Science*, 1941, 94, 49–50) proposed coating specimens with a solution of isobutyl methacrylate in toluene.

The writer found solutions of *Clarite X* in xylene a satisfactory coating for small animals (spiders, nymphs of Hemiptera, small caterpillars). The specimens were pinned and placed in 95-per cent alcohol, then in absolute alcohol. After a short immersion in xylene they were placed in a solution of 30-per cent *Clarite X* crystals in xylene for about two hours and then left to dry. The resin left a clear coating on the animal. No evidence of excessive shrinkage was observed. The color was preserved better than in the case of specimens kept in alcohol. The specimens were brittle but not much more so than pinned insects. A small addition of paraffin to the resin solution might make the resin less brittle without changing its other properties.

Clarite X, described as a cycloparaffin, may be obtained from the Neville Company, Pittsburgh, Pennsylvania, to which the writer is indebted for supplying samples of the resin for the experiments.

HERBERT W. LEVI

University of Connecticut

Algae in the Carlsbad Caverns, New Mexico

About two years ago there began to appear in the Carlsbad Caverns, on the pale-grayish limestone wall of the corridor opposite the bottom of the elevator shaft, a slight spotted greenish cast, which in time spread and brightened to a lettuce or grass-green color, not very dissimilar in appearance from the copper carbonate, malachite. It is not copper, however, even though such a supposition is reasonable, for sporadic copper stains are common over a wide area of the Guadalupe Mountains. It is caused by algae, chlorophyl-bearing plants, growing 750 feet below the surface where none have ever been seen before. There are two algae, a green and a blue-green—one an extremely fine aggregate or cluster of bright green cells, the other a pale green, fibrous form. Their habits are such that even their genera can be determined only with difficulty.

The events which have led to the growth of these plants deep down in the cavern are unusual. By December 1931 the elevator shaft was completed through 750 feet of limestone to the floor of the Lunch Room, and elevator service was begun. The corridor leading to the elevator doors was hewn out of solid limestone which was then dry and remained so for more than a decade. Over the elevator doors there was installed an electric light which has been kept burning for about seven hours each day ever since. No change was noticed until sometime in 1943, when a greenish color was first observed to be forming as faint blotches on the rock wall, and this brought to attention the fact that the rock was becoming moist.

To understand this situation better, let us examine certain local events of 1941 which may suggest a cause for the appearance of the algae. In May of that year a torrential rain fell in the Guadalupe Mountains and the surrounding area, which flooded the Pecos River and those of its tributaries heading in the Guadalupe Mountains. On 20 September an even greater deluge fell. Such storms are the result of an enormous accumulation of great, bulbous, cumulo-nimbus clouds which extend from the very ground to altitudes of more than 25,000 feet. To one who has experienced such storms in the field it seems as if the whole column of 25,000 feet of moisture overhead has condensed at the same moment. The Carson Seep Ranger Station reported 17 inches of rain, most of which had fallen in a few hours. During this storm 21.25 inches of rain fell at the headwaters of Dark Canyon, by far the greatest on record in the climatological history of New Mexico.

Though the percentage of run-off on a rocky terrain such as the Guadalupe Mountains is high, these two exceptional rainfalls produced such a notable recharge of

ground moisture that in the Fall of 1944 there came a stand of grama grass and other forage in the Pecos Valley the like of which had not been seen for forty years. In some pastures this luxurious display was due also to beneficial results of the Taylor Grazing Act, which has permitted the more sagacious cattlemen properly to husband their ranges.

It is believed that this increment of moisture, overcharging a perched watertable, has found a hitherto unused course through some 500 to 800 feet of rock and, after two years, is seeping out to moisten the rock wall of the corridor. Along with the water may have come the spores of algae; or possibly they were carried in by visitors to the cavern or by down-draft air currents in the elevator shaft. Whatever the mode of their introduction, germination was not possible until both light and water were available. Here in this cavernous void of total darkness no chlorophyl plant life has ever before penetrated so deeply below the surface and survived.

At the Devil's Pool, along the pathway leading down into the cavern from the Auditorium, an electric lamp illuminates for an hour or so each day a large moist stalagmite. A year ago a thin, hard, dark-green coating formed on the stalagmite that is probably the blue-green alga, *Schizothrix*. (In the Fall of 1945 it was noticed that the rock wall at the elevator shaft had grown drier and that the algae are shrinking into clusters. Algae are also to be seen now at the Green Lake and in the King's Palace.)

The only large display of algae growing under natural conditions is that found on the floor of the tunnel leading to the guano cave, 180 feet below the entrance. A cylinder of light, at times partly direct sunlight, projects down onto the rock-strewn floor. Within the circle of light a dull-greyish, black dirt appears to cover the debris. It suggests nothing living and gives rather the impression of being dusty, dead moss. A sample of it sent to Dr. Wm. Randolph Taylor was pronounced a blue-green alga, possibly *Gloeocapsa*, a simple-celled colonial form. This is probably the only place where daylight enters the cavern in sufficient amount to support the growth of a chlorophyl-bearing plant.

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WALTER B. LANG

Geological Survey
U. S. Department of the Interior

What Is the Matter With *Science?*

How is it that, six months after the first atomic bomb was dropped on Hiroshima—and on the world—neither its editors nor, apparently, any of its contributors, have made any serious and responsible effort to discuss the immense scientific, technical, and social ramifications of this event? Apart from the Truman statement—a document of minor scientific importance—some timely comment by Niels Bohr and Harold Urey, and a letter by Gordon F. Hull, this official journal of American scientists goes along as though nothing particularly out of the ordinary has happened.

A public interest, unprecedented in scope and magnitude, has been generated by the concrete realization of possibilities which a few years ago were shadowy dreams in the minds of men whose very language was an enigma to most of us. In Congress, on the radio, in magazines, books, lectures, and endless discussions, the question of atomic energy has assumed a grim and ruthless primacy upon whose right solution depend the patterns of human development—conceivably, even, of human survival. Nor can it be said that this urgent public concern is merely another example of mass hysteria that will soon pass because, this time, it originates in a fundamental scientific discovery that almost overnight has inscribed *mene mene tekel upharsin* upon the walls of our current civilization. Within the past weeks men like Oppenheimer, Szilard, Urey, Langmuir, Smyth, Langsdorf, Shapley, and many others have come out of seclusion and made headlines by their courageous, public-spirited response to the social outcome of their patient researches in nuclear physics. With a heartening unanimity these disciplined and sober minds have recognized the imperative need for thinking in terms of broad human objectives, in sharp opposition to a disgraceful chauvinistic nationalism whose conception of the method and purposes of science belongs on the level of Neanderthal man. Their own organization, the Federation of Atomic Scientists, is active in the promotion of a sane international handling of the myriad problems arising from their work, and quite recently a section of the American Physical Society has gone on record in favor of United Nations control of the atomic bomb.

Yet, so far, *Science* has nothing to say. Why is this? Are the editors themselves indifferent, or do they assume that the question of atomic energy is either too "secret" or too well known to deserve extended discussion? Can they find nothing to publish regarding developments in nuclear physics here and abroad, no statements by foreign scientists that go beyond trifling generalities, no simple and forthright reporting of events in this now-dominant field? Or is it that contributors simply do not care to write anything on the subject for their own magazine—something that will tell other scientists, as well as intelligent laymen, what they are doing and thinking, what the problems are and how they may best be approached with a hope of solution?

Whatever the answer, it seems to me that *Science*, in this matter, is lagging badly in what would appear to be one of its obligations: the prompt, intelligent, and reasonably adequate treatment of what J. D. Bernal has called "the social function of science." I say this without prejudice to the many vital and significant contributions that have appeared in its columns, and with due regard to editorial limitations of space, budget, etc. But I think it needs to be said, and reiterated, now more than ever, when thousands of plain folk are becoming vividly conscious of the enormous power wielded by scientists in our delicately balanced world. I think that the scientists themselves need to know it, to say it, to hear it said, over and over again, for I am convinced, on the basis of the way they have reacted to

the present atomic furore, that the great majority are men of good will, striving earnestly that their labors shall end, not in the acceleration of a disastrous social entropy but in the construction of a decent world for all of us.

HAROLD WARD

129 East 10th Street, New York City

The Prevention of Atomic Warfare

With reference to recent communications from William M. Woodward (*Science*, 1945, 102, 608) and Gordon F. Hull (*Science*, 1945, 102, 672), it is evident that there is a considerable desire for the formulation of plans to prevent the development of atomic weapons. No sane person would question the advisability of doing everything possible to bring this about. However, the methods suggested by these men are open to criticism, and their success is very doubtful. Although it was not mentioned by Mr. Woodward, the apparent *raison d'être* of the Association of Los Alamos Scientists is essentially that of attempting to limit the applications of atomic energy by collective action of the scientists, engineers, and technicians comprising it. They propose also to attempt the forcing of legislation on an international or "supernational" scale containing pledges against such military applications. Prof. Hull's plan for a World Association of Physicists is similar, but of his six points, only one is pertinent to the discussion, viz., "a pledge not to give advice concerning, nor assist in making, atomic bombs." Even if 99 per cent of the physicists of the world did so pledge, one could hardly presume that they could thus prevent misapplications of this science. The essential discovery of nuclear fission lies in the borderline field between chemistry and physics, but the deprivation of the project of physicists would not necessarily have prevented the development of a weapon, and in the future this will be much more true. Hence, this solution is as presumptuous as the one which supposes that the men who have had some connection with the manufacture of these weapons in the past have a corner on all the information needed for their production.

What we need, then, is not a Federation of Atomic Scientists, or of Bomb Builders, or even a World Federation of Physicists, but simply a World Federation. Most of the principles suggested as bases for the proposed associations are too obvious to bear elaboration, and the one which the ALAS has used as a smoke screen is virtually one of the purposes of the AAAS, *i.e.* "... to promote attainment and use of scientific and technological advances in the best interests of humanity."

It is strikingly clear to most of us that this is no time for forcing the hand of the State Department by demanding action on an international scale. This will require mutual respect, trust, and understanding of a high order—virtues which are not displayed by all of the present powers but which must precede any intimate discussion of the most potent force available to man.

JAMES H. PANNELL

Los Alamos, New Mexico

Veterans' Retraining Program in Geology

During the past five years it is estimated that the armed forces absorbed some fifteen hundred young American geologists of graduate, near-graduate, or postgraduate status, only a small number of whom had gained any experience in professional application of their learning.

During their terms in the armed services few of these young men have had the opportunity of using their geological training or of acquiring additional geologic knowledge. It may therefore be assumed that they have suffered considerable loss of geologic skill and knowledge and are thus not prepared to resume their studies or professional activities in competition with those geologists whose careers have not been interrupted by the war.

Because of this situation and the current demand for trained geologists, the U. S. Geological Survey proposes to undertake a program of training in the form of supervised field, laboratory, and office work that will enable discharged veterans to adjust themselves more quickly and with more confidence in resuming their careers. The Survey proposes to undertake only this applied phase of the retraining. It recognizes that many of the expected trainees will require preliminary academic courses in college or university geology departments that are equipped to give concentrated courses of graduate calibre.

The proposed dual program has been discussed with heads of the geology departments of the Universities of Chicago, Columbia, Harvard, Johns Hopkins, Princeton, and Yale; and they have indicated their approval of the plan in principle. Heads of geology departments in other schools interested in participating in this phase of the program may obtain pertinent information from the heads of the geology departments of those universities. Further information concerning the Geological Survey's phase of the program may be obtained by writing to W. H. Bradley, Chief Geologist, Geological Survey, Washington 25, D. C.

The instruction of qualified veterans in participating schools will, insofar as is feasible, be adjusted to the specific needs and interests of the individual to better equip him to undertake and benefit by Survey or other professional experience in field, laboratory, and office work during the 1946 field season.

Candidates for these temporary appointments to the Geological Survey will be selected on a competitive basis through the channels of the Civil Service Commission, and in accord with veterans' preference policies. It is hoped, however, that veterans who apply will have had the benefit of the preparatory college or university retraining before they seek appointment.

The number of veterans which the Survey will be able to absorb will depend upon the amount of funds appropriated to the Survey for geologic investigations. An estimate of the size of the field program should be available by spring after the House reports out the appropriation bill. As many as possible of the most competent temporary appointees will be given the opportunity of accepting more permanent appointments on the Geological Survey staff, or will be given aid in obtaining

appointments in other governmental agencies or in industry.

This dual program will operate on a very flexible basis, to take care of all individual cases, involving individuals whose academic training and professional experience to date lie within a rather wide range. It will be fitted also to individual desires, to allow for academic training only, for Survey experience only, or for both, depending on the qualifications and wishes of the individual.

W. H. BRADLEY, *Chief Geologist*
Washington, D. C.

Plea for Change in Regular Time of Meeting of the AAAS

Now that the regular meetings of the AAAS are to be resumed, it seems appropriate to consider anew the best time for holding them. There would seem to be three leading possibilities which have been, or are about to be utilized, *i.e.* the traditional Christmas holiday period; the early spring, to be tried this year; and the early fall, shortly following Labor Day, which was tried at Cleveland.

First, as to the traditional Christmas holiday period, the following considerations seem to be pertinent: To reach the meeting at this time it is often necessary to leave home on Christmas night or, at the latest, the day following. This frequently disrupts family gatherings and makes what should be an event to be looked forward to a disagreeable task. It is quite commonly made more disagreeable by extremely inclement weather, late trains, stuffy sleeping cars, and the seasonal presence of the virus of the common cold, not to mention more serious respiratory ailments.

Second, as to the early spring, this may be said: The general conditions at this season, it is true, are no doubt better than those at Christmas, *i.e.* if the time chosen is sufficiently late or "spring" is sufficiently early. Granting, however, that weather conditions are entirely propitious, irregularities in the dates of the spring recesses in the various colleges and universities are bound to make attendance impossible for many, no matter what particular time is set. Incidentally, also, even if the meeting should happen to coincide with one's own recess period, it would consume virtually all of this brief time of respite in the long winter-spring term, a respite often sorely needed to catch up with various odds and ends of work.

Third, in favor of a period shortly following Labor Day the writer would like to urge the following arguments: At this time of year summer vacations for almost everyone have ended, while the fall terms of most institutions on peacetime schedules have not yet started, thus leaving a convenient interim. Also, contrary to the condition at the Christmas season, no holiday celebrations are interrupted, the trains, if one wishes to use them, are reasonably on time, and the weather is such as to make trips by car possible and often pleasurable. It is the writer's belief that all who attended the recent Cleveland meeting held at this time of year will agree that the conditions indicated were fulfilled. Unfortunately, however, wartime exigencies prevented as large an attendance at this meeting as is customary. Why, therefore, not try this time of meeting again under more normal conditions?

It is hoped that this note may stimulate others who favor the view herein expressed to urge favorable consideration of this change upon those concerned in the scheduling of this important event. Indeed it seems as though the matter is of enough significance so that in case of doubt as to the extent of opinion in favor of such a change, a mail ballot of the membership might well be undertaken.

ROBERT S. MCEWEN
Oberlin College, Oberlin, Ohio

The Law of Precharged Luminescence

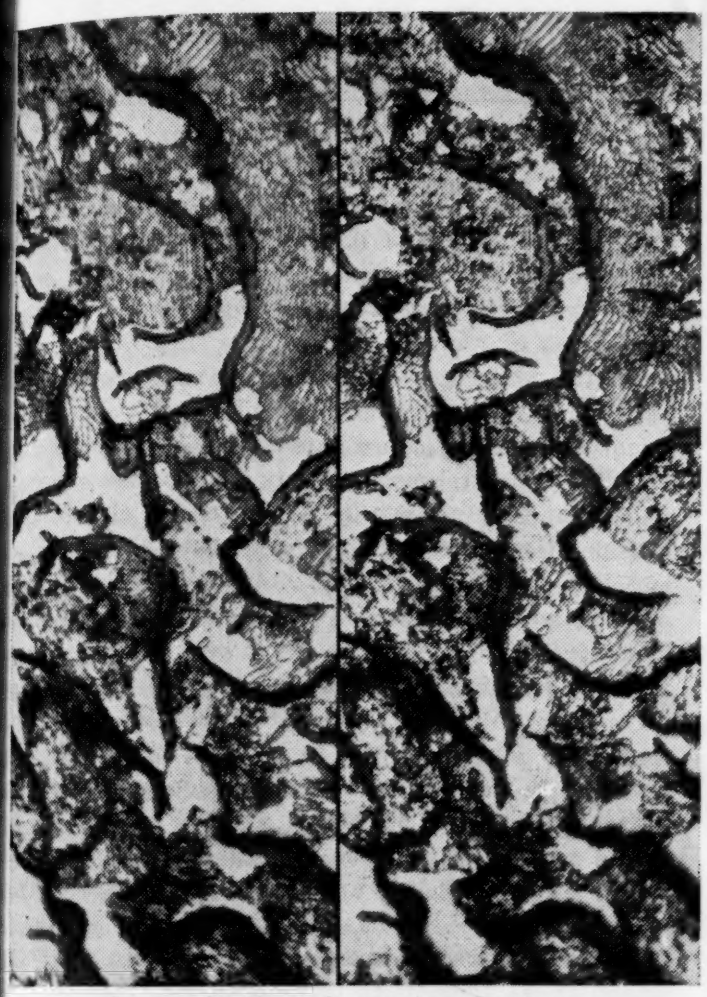
According to the excitation processes which occur in a light-emitting system, the resulting luminescence may originate in one of several mechanisms: (a) direct excitation, (b) indirect or sensitized excitation, (c) translocated excitation, and (d) precharged excitation (J. De Ment. *Fluorochemistry.* New York: Chemical Publishing Co., 1945). The present communication relates to (d), the precharged luminescence, in which the luminescent system retains the effect of a history of radiation for considerable periods of time (e.g. months or years) and at a later time emits light when subjected to low-temperature heat, friction, and similar agents. The best-known examples of precharged luminescence include the family of thermoluminescences, certain of the triboluminescences, and a number of sundry phenomena.

In a recent study and compilation of the known types of luminescence, in which some two hundred varieties were listed, the present writer (*Fluorescent chemicals*, Vol. 3: *Dictionary of luminescent substances.* New York: Chemical Publishing Co., in press) noticed a rather obvious characteristic common to all of the precharged luminescences, to which attention does not seem to have been directed before this time. This common feature can be formulated into a law covering the known types, since no violation has been discovered by the writer in the many examples he has studied. Consequently, the *law of precharged luminescence* is as follows:

"In a system exhibiting precharged luminescence, the energy responsible for the radiation history in that system is always greater than that energy required for the release of the luminescence."

While it is not possible to list here every known case of precharged luminescence to corroborate the foregoing statement, certain well-known examples suffice to clarify what it means. Thus, in the family of thermoluminescences, the agents which provide the radiation history or precharging include radioelement radiations, cathode rays, X-rays, ultraviolet light, visible light, and a number of miscellaneous corpuscular radiations like neutrons. The thermoluminescence takes place when the previously irradiated system is then subjected to such low-energy agents as infrared rays (heat), pressure disturbances (e.g. scratching and grinding), as well as radiations like visible light which are of less energy than that employed for the irradiation.

JACK DE MENT
Fluorescence Laboratories, Portland, Oregon



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Book Reviews

Heredity and its variability. T. D. Lysenko. (Translated from the Russian by Th. Dobzhansky.) New York: King's Crown Press, Columbia Univ., 1946. Pp. vi + 65. $.50.

For a number of years biologists have been puzzled by the claims of the Russian agronomist, Lysenko, that Mendel's principles of heredity are all wrong and that acquired characters are inherited after all. The original technical papers and books of Lysenko and his followers have been published only in Russian and in general have not been available in the United States or in English translation. In order that Academician Lysenko's work may be judged by biologists who do not read Russian, Prof. Dobzhansky has provided an adequate, literal, and unannotated translation of the 1944 edition of Lysenko's latest book, which was first published in the USSR in 1943. It is thus possible to consult a systematic statement of the author's views in his own words, rather than the indirect accounts contained in translations and criticisms of the debates which he has carried on with Russian geneticists.

Here we find a full, if somewhat repetitive, account of Lysenko's views on reproduction, heredity, inheritance of acquired characters, effects of environment and mutation, in addition to a discussion of some of the problems of plant improvement. It is written from the point of view of a practical agronomist, confines itself almost exclusively to plant material, chiefly the cereals with which Lysenko has worked, and is addressed to a general agricultural audience rather than to a scientific and sophisticated one.

In general, detailed evidence is not given to support the broad generalizations which are made, nor are references given to published experimental data. Instead, brief summaries of results obtained by Lysenko's students and collaborators are presented. Some of these are most remarkable, and it is to be hoped that plant breeders will examine the original data when these become available. For example, a case of vegetative hybridization is reported (pp. 32–35) in which seeds from a branch of a white-fruited tomato grafted on a red-fruited host gave mostly red-fruited offspring, but seeds from these gave in later generations both white- and red-fruited forms.

In later chapters (VII, "Liquidation of the conservatism of the nature of organisms"; and VIII, "The sexual process") equally remarkable results are described in summary form, from which it is concluded that genetically spring varieties of cereals can be permanently converted into winter varieties and vice versa by subjecting the germinating seeds to altered temperatures. From these and other references to altered environment and to constant hybrids, paternal inheritance, maternal inheritance, and parthenogenesis it is concluded that "the heredity of plant organisms may be altered by altered nutrition" and that "it is possible to alter and to create varieties with a desirable heredity by controlling conditions of the external environment, the living conditions of the plant organisms. *The heredity is, as it were, the essence of the conditions of the external environment assimilated by the plant organisms in a series of preceding generations*" (p. 65).

On the whole the book reveals a man whose purpose is different from that not only of geneticists but of scientists generally, since he seeks not so much to understand as to control more directly the processes of nature, and to condemn not merely Mendelism but all theoretical considerations which do not contribute directly to this end. His purpose was to provide new and better methods and improved varieties of plants for the vast expansion of Soviet agriculture which was taking place on the collective farms, and his position and prestige were probably attributable to the promise which his methods seemed to Soviet planners to hold out in this direction, particularly the method of jarovization or vernalization of cereals which is associated with his name.

The author of this book appears as a kind of biological fundamentalist, and the scriptures according to which he interprets his observations were written by Darwin, Lamarck, Spencer, and other nineteenth-century scientists, as these were introduced and popularized in Russia by Timiriazev and Michurin, Lysenko's immediate predecessors and mentors. The primary cause of Lysenko's differences with the geneticists is his adherence to these old views of reproduction and inheritance with which the theories and facts of Mendelian heredity are incompatible. This is clearly brought out in Chapter III, "Individual development of the organism." The author supposes (p. 9) that "the sex cells or buds from which as a rule develop whole organisms are the products of the development of the entire organism which produces these beginnings of new organisms. *They arise from molecules, from granules of various organs* and parts of the organism many times but regularly altered." This is the view tentatively put forward in Spencer's theory of physiological units (1864) and in Darwin's hypothesis of pangenesis (1868) and quickly disproved and abandoned. In supposing that the germ cells derive their properties from the other cells of the organism this view is the inverse of that generally held for the last 60 years, namely, that the germ cells transmit a stable system of determiners which guide the development of the cells which arise from them.

Needless to say, Lysenko also denies that genes or chromosomes have anything to do with heredity and rejects the most fundamental principle of heredity in the following words:

"The Mendelians foist this 'pea law,' according to Michurin's happy expression, on the whole of living nature. But in reality it is basically wrong even for pea hybrids, including the factual material obtained by

Mendel himself. The progenies of different hybrid plants varied even in Mendel's experiments much beyond the ratio 3:1. Thus, in the offspring of one plant there were 19 yellow and 20 green seeds, and of another plant—only a single green for 30 yellow ones'' (p. 55).

Lysenko's ideas on reproduction and development derive, as did those of Darwin and Spencer and Michurin, not from experimentally ascertained facts but from the need for a mechanism by which another supposed fact, the inheritance of acquired characters, may be explained. The need for such a mechanism disappeared with the failure of proof of the inheritance of acquired characters. No new proofs are given in this book.

It has been apparent for a long time that Mendelian heredity, as the orderly transmission of relatively stable units (genes) and the inheritance of direct effects of the environment or of training and similar modifications could not both be true. Lysenko clearly believes the evidence for the latter to be more convincing than that for Mendelian heredity. While that view was possible in the Nineteenth Century and to those who ignore the modern facts of heredity, it is strange to encounter so crude a restatement of it in a country where such striking progress in genetics was made as in the USSR between 1920 and 1940. It seems an anachronism somewhat like the denial of the facts of evolution over large areas of a country as progressive as the USA. In both cases the causes of such attitudes seem to those outside the country to be obscure and puzzling. In both cases also the scientific position of the country is so strong that the heterodox views of small minority groups may safely be left to the judgment of time and progress.

L. C. DUNN

Columbia University

The fortress islands of the Pacific. William Herbert Hobbs. Ann Arbor: J. W. Edwards, 1945. Pp. xiii + 186. $2.50.

This interesting little book is a welcome addition to the meager list of informational volumes on the Pacific. Considering its vast area, the Pacific was surprisingly little known at the beginning of the recent Japanese war. This was particularly true of the territory mandated to Japan. The Carolines, the Marshalls, and the Marianas were then islands of mystery. Because of extended tours in 1921 and 1923, during which careful notes and maps were made, Professor Hobbs was probably the best-informed person in America on the geologic and geographic aspects of this section of the Pacific at the time of Pearl Harbor.

The book is well illustrated with numerous original maps, diagrams, and pen drawings. The author divides all Pacific Islands into two great groups, the ''Arcuate Islands'' and the ''Strewn Islands.'' A more detailed classification, based largely on origin, results in the following types: group volcano islands, volcano islands, almost-atolls, atolls, part-raised atolls, raised atolls, newborn arcuate islands, and youthful arcuate islands. Each type forms the subject matter of a separate chapter in which well-chosen examples are used as illustrations. The chapter on the Origin of the Islands is not all which

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might be desired. This is particularly true of the section dealing with the origin of the Strewn islands. The entire Pacific basin is described as an area of shrinking and sinking. Before the sinking began, huge volcanoes were built up at hundreds of points. During the subsequent subsidence the sea eventually occupied the region, and most of the "volcanoes disappeared completely beneath the waves and their positions are indicated today by coral growths built up over them as upon a pedestal—the coral islands or atolls." Although the Darwinian theory of atoll formation lends itself nicely to what is required in a popular book of this type—a simple explanation of atoll formation—still, the facts produced by careful study of the islands demand a much more complex explanation of their origin than is outlined here.

A chapter on the military value of each island type is the unique contribution of the book. A well-chosen bibliography is appended. Professor Hobbs writes clearly and interestingly. Geologists should produce more books of this character instead of leaving it to those less qualified.

J. EDWARD HOFFMEISTER

University of Rochester

The Woods Hole Marine Biological Laboratory. Frank R. Lillie. Chicago: Univ. Chicago Press, 1944. Pp. x + 284. (Illustrated.) $4.00.

Unique in the history of scientific enterprises in the United States is the Woods Hole Marine Biological Laboratory. It is unique in organization, history, and in the scope of its service both to the biological sciences and to the nation. It is national in its services, democratic in organization, and international in its relations. The Naples Biological Station had minimum support from the United States and Great Britain; but in control, staff, and clientele was always essentially German and in recent years has become Italian. It never had the support of France, Russia, or the other European states. The Woods Hole Laboratory, on the other hand, has had the loyal support of many of the leading American universities and colleges, especially of the Atlantic seaboard and Middle West. These were represented in its board of trustees, staff, and clientele. It is fortunate that the history of this institution has been written by one long connected with its operations and while the most of those who have shared in its development are still living.

This book is an important document in the history of the biological sciences on this continent. Its illustrations picture the faces of most of the teachers and investigators of these sciences in the United States during the flowering period of biology in America. Its one great defect is the absence of a suitable likeness of its distinguished author.

The influence of Louis Agassiz and his pupils is evident in the history of the Woods Hole Institution, which is the heir of the short-lived institution at Penikese. Even more dominant in the heredity is the influence of the rapidly growing interest in animal morphology and embryology which stemmed from the laboratories of Leuckart and Balfour and soon burgeoned from the newly established chairs in our universities as natural history gave way to the newer specialties.

One chapter is devoted to the later-established sister institution, the Woods Hole Oceanographic Institution. One function of this marine laboratory has always been its class instruction which brought young biologists under the potent influence of the leaders in the American biological sciences under circumstances which inspire both effort and enthusiasm. The effect of this function upon the expansion and quality of American teaching and research is imponderable but potent.

CHARLES A. KOFOID

University of California, Berkeley

Scientific Book Register

BEST, CHARLES HERBERT, and TAYLOR, NORMAN BURKE. *The physiological basis of medical practice: a University of Toronto text in applied physiology.* (4th ed.) Baltimore: Williams and Wilkins, 1945. Pp. xiii + 1169. (Illustrated.) $10.00.

COLLINGWOOD, R. G. *The idea of nature.* New York: Oxford, 1945. Pp. 192. $4.00.

FITCH, LYLE, and TAYLOR, HORACE. (Eds.) *Planning for jobs: proposals submitted in the Pabst post-employment awards.* Philadelphia: Blakiston, 1945. Pp. xxii + 463. $3.75.

FULTON, JOHN F. (Ed.) *Howell's textbook of physiology.* (15th ed.) Philadelphia: W. B. Saunders, 1946. Pp. xxxv + 1304. (Illustrated.) $8.00.

LUSH, JAY L. *Animal breeding plans.* (3rd ed.) Ames, Iowa: Collegiate Press, 1945. Pp. viii + 443. (Illustrated.) $3.00.

MACGREGOR, GORDON. *Warriors without weapons: a study of the society and personality development of the Pine Ridge Sioux.* Chicago: Univ. Chicago Press, 1946. Pp. 228. (Illustrated.) $3.75.

MASSERMAN, JULES H. *Principles of dynamic psychiatry: including an integrative approach to abnormal and clinical psychology.* Philadelphia: W. B. Saunders, 1946. Pp. xix + 322. (Illustrated.) $4.00.

MERRITT, ARTHUR H. *Peridontal diseases, and soft tissue lesions of the oral cavity.* (3rd ed.) New York: Macmillan, 1945. Pp. 276. (Illustrated.) $3.50.

POSNANSKY, ARTHUR. *Tihuanacu: the cradle of American man.* New York: J. J. Augustin, 1945. Vol. I: Pp. viii + 158; Vol. II: Pp. viii + 246. (Illustrated.) $30.00.

RICHTER, KENNETH M. *A work-text on human embryology.* St. Louis: John S. Swift, 1945. Pp. 1[illegible]. (Illustrated.) $3.75.

TURNER, RUFUS P. *Radio test instruments.* Chicago: New York: Ziff-Davis, 1945. Pp. xiii + 219. (Illustrated.) $4.50.